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ABSTRACT

The purpose of this study is to develop and demonstrate the use of a conceptual framework for assessing the potential of "world view" as a concept for understanding important issues in science education. The framework is based on Stephen C. Pepper's treatment of six world hypotheses (animism, mysticism, formism, mechansim, contextualism, and organicism) in his book WORLD HYPOTHESES. The study has three major parts. The first is the development of the framework (analytical scheme). The second is its use as a perspective for understanding the relationship between world view and social issues, with special reference to the relevance of this relationship to curriculum concerns. The third is a case-study, demonstrative analysis of a biology textbook, which shows how the analytical scheme can be used to detect the projection of world views to students in science teaching materials. (Author/MH)

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IDENTIFYING WORLD VIEWS PROJECTED BY SCIENCE TEACHING MATERIALS: A CASE STUDY USING PEPPER'S WORLD HYPOTHESES TO ANALYZE A BIOLOGY TEXTBOOK

by

Brent Kilbourn

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IDENTIFYING WORLD VIEWS PROJECTED BY SCIENCE TEACHING MATERIALS: A CASE STUDY USING PEPPER'S WORLD HYPOTHESES TO ANALYZE A BIOLOGY TEXTBOOK

(Abstract)

The purpose of this study is to develop and demonstrate the use of a conceptual framework, based on Stephen C. Pepper's *World Hypotheses*, for assessing the potential of *world view* as a concept for understanding important issues in science education. The study has three major parts. The first is the development of the framework (or analytical scheme). The second is its use as a perspective for understanding the relationship between world view and social issues, with special reference to the relevance of this relationship to curriculum concerns. The third is a case-study, demonstrative analysis of a biology textbook, which shows how the analytical scheme can be used to detect the projection of world views to students in science teaching materials.

The development of the analytical scheme is in response to the lack of *systematic* and *comprehensive* frameworks in science education for assessing the potential consequences for students of messages about world views. Pepper's concept of world hypotheses is used as the basis for the framework because his treatment of six world hypotheses (animism, mysticism, formism, mechanism, contextualism, and organicism) is both systematic and comprehensive. Characteristics that serve as identifying features of the six world hypotheses

are abstracted from Pepper's work to form the scheme.

The second part of the study is the use of the framework to demonstrate substantive linkages between current social issues and curriculum concerns. Social issues of interest to this investigator concern recent literature on ontological anxiety which suggests that a "mechanistic world view" has been a significant factor in the development of such existential problems. Two current intellectual movements are identified ("systems" and "religious"), both of which signal a move away from a mechanistic world view. The key terms of these two movements are accommodated using world hypotheses, and curriculum implications are drawn. An illustrative example of the implications of using Pepper's work to confront curriculum concerns is provided by examining a current issue in science teaching, namely the creation/evolution controversy.

The last part of the study is the use of the scheme for a case-study, demonstrative analysis of science teaching materials, in order to consider its usefulness as a tool for examining one of the realities of science education: the materials used by learners (in this case a biology textbook). There is a substantive linkage between this case-study analysis and the assumption that people are affected by the world views they acquire and/or develop. This analysis of science teaching materials explores one way in which students acquire world views--through the textbooks they study.

Evidence from the analysis shows that world hypotheses are projected primarily by implication. Some of these are found to be associated with underlying issues in the discipline of biology. That is, classification and the description of organisms tend to project formism. Discussion of the status of natural laws, theories, and classification schemes suggests contextualism. Causal explanation tends to project mechanism, while historical accounts of research indicate features of organicism.

Limitations of the analytical scheme center on three issues. One is that there is some overlap among the characteristics of various world hypotheses, which increases the difficulty of making distinctions about their projection in nonphilosophical material. Another is an inherent weakness of organicism for dealing with certain aspects of biology that are even less adequately dealt with by using any of the other five world hypotheses. (Homeostasis is an example.) A third limitation is associated with a difficulty in content analysis of any kind: the extent to which relevant context should influence judgments.

Several rather clear points emerge from this study. The detection of projected world hypotheses in science teaching materials is extremely complex but the potential consequences of that projection are so far-reaching as to warrant persistence in this line of research. Further, if teaching is to provide for a student's intellectual independence, provision needs to be made for awareness that, in a sense, world views provide a basis for knowledge claims. Finally, and most importantly, the conceptual framework used in this study emerges as a powerful way for dealing with important issues in science education.

I want to express my deepest appreciation to my advisor and friend, Doug Roberts, for his unfailing intellectual and emotional support during the writing of this study and throughout my tenure as his student. I want to thank Ed Brent and Ervin Laszlo for their careful reading and thoughtful criticism of the study. My appreciation, thanks, and love go to Barbie.

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CHAPTER I

OUTLINE OF THE STUDY

Introduction

This is an exploratory study in which science textbook material is analyzed from the perspective afforded by "world view," as that term indicates an individual's perception of the nature of reality and how reality is known. The study has two parts: (a) development of an analytical scheme for detecting and distinguishing among world views projected to students by teaching materials, and (b) an exploratory demonstration of the use of the scheme in a case-study application to a biology textbook. The scheme is based on the systematic philosophical framework in Stephen C. Pepper's World Hypotheses.[1]

An important assumption of the study, discussed in detail later, is that the projection of world views to students has the potential to produce far-reaching consequences for those students and their society. While the conceptualization of this study is probably appropriate to several aspects of the school curriculum, it is particularly germane to issues in science education. For that reason the scheme is applied to a science textbook, and no attempt is made to specify implications for curriculum in general.

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[1] Stephen C. Pepper, World Hypotheses: A Study in Evidence (Berkeley: University of California Press, 1942, 1970). Originally published by the University of California Press; all passages quoted in this document are reprinted by permission of The Regents of the University of California.

The Problem

The problem dealt with in this study is the lack of conceptual frameworks in science education for assessing the potential consequences of world view for students. The context appropriate for understanding the nature of the problem is that of a culture's world view, and how the young of the culture come to adopt it. Particularly, this refers to the intellectual institutions (e.g., religion, science, magic) to which a culture turns for its sense of reality. It is apparent that Western culture becomes knowledgeable about what is real predominantly through science. Roszak elaborates this notion.

> The mindscape to which our culture has been shaping itself over the past three centuries--and with ever more decisive urgency since the advent of industrialization--is the creation of modern science. . . . What is important in the examination of a people's mindscape is not what they articulately know or say they believe. In that respect, our society is, at the popular level, all but scientifically illiterate. What matters is something deeper: the feel of the world around us, the sense of reality, the taste that spontaneously discriminates between knowledge and fantasy. It is in all these respects that science has become the dominant force in designing the psychological and metaphysical basis of our politics.[1]

One manifestation of science as a dominant force in North American society is the existence of required science courses in the school curriculum. An example of the way in which science teaching materials advocate a particular sense of reality, or world view, can be seen in this passage from a text widely used in Grade 13 biology in Ontario.

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[1] Theodore Roszak, Where the Wasteland Ends (Garden City, New York: Doubleday & Company, Inc., 1972), p. xxiv.

> A study of natural science includes knowledge of the structure and behavior of matter, inorganic chemistry and physics, and observations on the structure and behavior of organic matter and living things, organic chemistry and biology. Natural science is, therefore, a study of the universe to which we belong and is, in essence, a continuous search for truth as revealed by observation and interpretation of the universe.[1]

Here it is evident that a message is being presented about the appropriateness of science as a way to view knowledge, reality, and truth.

Sense of reality (world view) as a comprehensive but imprecise concept

Emerging from this discussion is the consideration that "sense of reality," or "world view," is a comprehensive concept, the exact nature of which is difficult to specify. It is metaphysical to the extent that it embodies questions about the nature of reality and epistemological to the extent that it implies how reality is known. In spite of the imprecision of this concept, however, intuitively there is strong reason to believe that it is a potentially useful conceptual tool.

For purposes of this study the term world view (rather than sense of reality) is used to designate the comprehensive, imprecise concept under discussion. Later in this chapter a more technical term (and more systematic concept) is introduced: the term world hypothesis from Pepper's work. In this study the term world hypothesis is considered a species of the generic term world view.

Questions provoked by world view

A second consideration emerging from this discussion is that conceptual, empirical, and value questions arise from considering world view in the context of a society's educational system. Some questions have their origin in the conceptualization of world view and must be dealt with before certain empirical and value questions can be formulated effectively.

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[1] Fred M. Speed, General Biology (Columbus, Ohio: Charles E. Merrill Books, Inc., 1966), pp. 369-370.

But the empirical and value questions are important also: if they can be resolved meaningfully they may help point to curriculum prescriptions. For example, an answer to the empirical question, What effect does the projection of world views have on students? might be information necessary to cope with the questio[illegible]ould provision be made for students to be aware that world views provide an intellectual foundation for knowledge claims? Such a value question obviously has implications for curriculum.

Scientific world view and curriculum

A final consideration leads to further elaboration of the problem of this study. The concept world view provokes questions having curriculum implications. Within this concept are more specific, but still somewhat imprecise, concepts such as "religious world view," "scientific world view," "mystical world view," "materialist world view," etc. Each of these has associated conceptual, empirical, and value questions having curriculum implications. However, the importance of those questions as they relate to "scientific world view" looms large. As noted earlier, a scientific world view has emerged as a dominant force in North American society by guiding the way in which truth, knowledge, and reality are perceived. Furthermore, the inculcation of a scientific world view is, by definition, blatant in the science classroom. As Roberts has pointed out, "virtually every science teaching program tries to get youngsters to adopt a scientific way-to-explain. . . ."[1]

Lack of conceptual frameworks

Of course, research on science teaching, including rationales, methods, objectives, and content, is conducted primarily by a specialized group of scholars in the field of science education. Questions dealing with world view and more specifically with scientific world view are appropriate to this domain of research. But they are not being asked.

And now the problem of concern to this investigator can be stated more emphatically: conceptual frameworks are lacking in science education for dealing systematically with curriculum issues related to world view, and indeed there are virtually no indications of interest in and concern for such research. In spite of the unprecedented amounts of money spent on science education research and development in the past twenty years, broader metaphysical implications of learning science have been largely ignored. For example, an entire issue of the authoritative Review of Educational Research was devoted recently to science and mathematics education,[2] and in that issue no reference is made to metaphysical concerns in connection with science curriculum development,[1] curriculum evaluation,[2] or learning studies.[3] And, in the same issue, Robinson notes the paucity of studies in science teaching that confront any philosophical concerns.[4]

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[1] Douglas A. Roberts, "Science Education Viewed as an Indoctrination Process." (Presented at a symposium, "The Limitations of Scientific Literacy," at the 1972 Convention of the National Science Teachers Association, New York. Abstracted in: NSTA Twentieth Annual Meeting: Addresses and Reports, 1972.)

[2] Review of Educational Research, XXXIX (October, 1969). This special issue reviewed science and mathematics education research from 1964-1969.

In particular there seem to be no studies dealing centrally with any aspect of metaphysics related to the comprehensive notion of world view used in this thesis. On the one hand, this could reflect lack of recognition that issues related to world view might be significant. On the other hand, it might be a result of the lack of philosophically systematic conceptual frameworks for assessing the potential of world view as a factor having intellectual consequences for students.

To be sure, there is some research in science education which is related, though peripherally, to this investigator's concerns. The relationship of that research to the present study is examined in detail in Chapter IV; nevertheless it is useful here to mention the work of two investigators as examples.

Schwab has touched upon issues dealing in a broad way with world view by using the idea of "principles of enquiry" as a means for conceptualizing curriculum problems in terms of the bases for knowledge and truth in science.[1] Yet his investigations are not cast in terms of world view, nor do they include an attempt to provide philosophical roots to the constellation of concepts involved in "principles of enquiry." More about Schwab's work is found in Chapter IV.

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[1] Herbert A. Smith, "Curriculum Development and Instructional Materials," ibid., pp. 397-413.

[2] Wayne W. Welch, "Curriculum Evaluation," ibid., pp. 429-443.

[3] Maurice Belanger, "Learning Studies in Science Education," ibid., pp. 377-395.

[4] James T. Robinson, "Philosophical and Historical Bases of Science Teaching," ibid., pp. 459-471.

Again, Slesnick stipulates a definition for "rational image of the universe," as part of the rationale for a unified science curriculum.[2] His concept seems at first reading to be similar to "world view," but it is neither comprehensive nor systematic. His "rational image of the universe" is confined to selected aspects of what is here termed loosely a "scientific world view." Slesnick's work is not pursued further in Chapter IV.

A comprehensive and systematic notion of world view simply does not appear as the central concern of any studies in science education. This would hardly be considered noteworthy were it not for the fact that the significance of world view as a focus for research lies in its potential for confronting curriculum problems related to the concerns of a number of social critics--concerns which are often stated in terms of world view.

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[1] Joseph J. Schwab, "Problems, Topics, and Issues," in Education and the Structure of Knowledge, ed. by Stanley Elam (Chicago: Rand McNally & Company, 1964), pp. 4-43. Also see Schwab's "What do Scientists Do?" Behavioral Science, V, No. 1 (1960), pp. 1-27. For applications of "principles of enquiry" to issues in science education, see: F.M. Connelly, "The Structure of Plant Ecology with Special Reference to the Ecosystem Concept " (unpublished Ph.D. dissertation, University of Chicago, 1968). Also see: B. Kilbourn, Analyzing the Basis for Knowledge Claims in Science Textbooks: A Method and a Case Study, Background Paper No. 6 for The Explanatory Modes Project (Toronto: The Ontario Institute for Studies in Education, Department of Curriculum, 1971).

[2] I.L. Slesnick, "Unified Science in the High School Curriculum," Journal of Research in Science Teaching, I (December, 1963), pp. 302-314.

Description of the Study

The argument of this study has three distinct "steps." First, a conceptual framework is developed in Chapter II in the form of a scheme for analyzing science teaching materials. Once developed and available for inspection by the reader, the conceptual framework (analytical scheme) is used in a second step to demonstrate substantive linkages between current social issues and curriculum concerns (Chapter III). Related research is examined in Chapter IV. The final step of the argument is the application of the scheme to a biology textbook, as discussed in Chapter V. Chapter VI reports the summary and implications of the study.

This document is structured in such a way that the major argumentative steps of the thesis are presented without undue interruption for the reader. Thus a substantial body of material is contained in five appendices.

"World Hypotheses" as the basis for the scheme

The analytical scheme developed in Chapter II constitutes the kind of conceptual framework now lacking in science education for dealing with curriculum issues of central importance to this investigator. As noted earlier, the scheme is based on Pepper's World Hypotheses. The comprehensive but imprecise concept world view is replaced, for purposes of the scheme, by Pepper's concept world hypothesis in order to gain the advantage of his systematic treatment (an advantage not available for the concept world view, as discussed below).

Of course, Pepper is not the only scholar who has been concerned about world view. Yet his systematic treatment is extremely valuable because he distinguishes among world views by tracing his world hypotheses to their philosophical roots. This he does by developing what he calls the root-metaphor theory to account for different schools of philosophy on the basis of common-sense metaphors that give rise to coherent systems of thought. A root metaphor is essentially a basic analogy.[1] He also constructs categories (i.e., basic concepts used for explanation and description) which serve as further identifying features of six world hypotheses: animism, mysticism, formism, mechanism, contextualism, and organicism. A theory of truth is elaborated, appropriate to each world hypothesis.

By contrast, consider the way in which "world view" enters the work of, say, Robert Redfield, with whose name the concept is frequently associated.

> We might mean by "world view" or Weltanschauung the total inside view of a cultural community as it is learned about and assembled by the student on the outside of that community. In describing the world view, the student would take account of such categories of experience as he finds implicit in the conduct and language of the native, whether or not the natives as a whole state these categories to themselves.[2]

It is clear that Redfield is concerned primarily with an attitude to be taken in ethnological research, and with describing world views implicit in native explanations of phenomena. He is not concerned with explicating the identifying features of alternative world views, or with demonstrating how these features are linked to form coherent positions.

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[1] An overview of Pepper's root-metaphor theory is presented in Appendix I. The reader's attention is directed to it at the appropriate place in Chapter II.

[2] Robert Redfield, The Little Community and Peasant Society and Culture (Chicago: University of Chicago Press, 1960), p. 91.

Redfield's approach, while certainly valid for his purposes, is a prototypical example of treating the concept of world view at the level of "naive metaphysics." Pepper's treatment, as noted by Reck, is quite different (and therein lies its strong appeal): "*World Hypotheses* presents a theory about metaphysics, not a metaphysics."[1] The work has *prima facie* relevance to the problem of this investigation because it is philosophically systematic and it delineates six alternative world hypotheses. There is minimum categorial overlap among the world hypotheses and, consequently, maximum potential for developing a scheme by which to distinguish among them in science teaching materials.

Development and application of the scheme

World hypotheses have characteristics which can be used to identify their projection in written material, including root metaphors (basic analogies), categories (basic concepts used for explanation and description), and theories of truth. The investigator has abstracted these characteristics from Pepper's analysis, treated them as a coherent structure of clues, and organized them in a series of statements which constitute the analytical scheme.

Development of the scheme took a more circuitous route than is suggested by the preceding straightforward statement of the way in which it was finally organized. After initial study of Pepper's work, the investigator analyzed some non-textbook material which suggested intuitively that it would show gross distinctions among several world hypotheses. This preliminary analysis was promising. The material was selected deliberately because it was rather transparent with regard to world hypotheses, and the fruitful results of the preliminary analysis contributed to the final decision to use Pepper's work for this study. In addition, it pointed up necessary refinement in the investigator's thinking about the organization and clue structure which would have to emerge as the final version of the analytical scheme. The preliminary analysis is sufficiently important to the development of this study that it is presented *in toto* as Appendix II.

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[1] Andrew J. Reck, *The New American Philosophers: An Exploration of Thought Since World War II* (New York: Dell Publishing Co., Inc., 1968), p. 47.

The final version of the scheme is developed in Chapter II and displayed in its entirety as Appendix III. It is used by the investigator in a case-study exploratory analysis of one biology textbook, chosen in the following manner. Six textbooks on general biology are approved by the Ministry of Education, Ontario, for use as student texts and supplementary references in the Grade 13 biology course.[1] Selected from among these by a random-numbers process, the textbook analyzed in this study is *General Biology* by F.M. Speed.[2] Detailed analysis of the textbook, discussed in Chapter V, is presented in Appendix IV. Some 150 pages of the textbook itself are reproduced in Appendix V; the rationale for selecting those particular pages (rather than reproducing the entire textbook) is found in Chapter V.

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[1] Ministry of Education, Ontario, *Textbooks: Circular 14, 1972*, pp. 77, 90.

[2] Fred M. Speed, *General Biology* (Columbus, Ohio: Charles E. Merrill Books, Inc., 1966). All passages quoted and reproduced in this document by permission of Charles E. Merrill Books, Inc.

Chapter V also contains a detailed account of the procedure used in applying the scheme and interpreting the analysis. Sections of text (paragraphs, sentences, phrases) are examined to determine which world hypothesis best accounts for what is stated. The results of the analysis are inferences about the projection of world hypotheses within a section. Obviously the notion of projection is crucial to the analysis and the study; a stipulative definition is therefore given to the term. A world hypothesis is judged to be projected if (1) it is overtly expressed, (2) it must be assumed for the section to be intelligible, or (3) it is implied.

The yield of the study consists, then, of the scheme itself and the results of the detailed analysis; in addition, commentary about the application of the scheme is centered upon three questions.

1. In what ways are messages about world hypotheses presented to students (e.g., by implication, directly, within a framework for informing the reader)?
2. Are some world hypotheses associated with underlying issues in the textbook (e.g., substantive issues in the discipline of biology)?
3. What difficulties are encountered in applying the scheme?

Exploratory nature of the study

The emphasis of this study is on developing a defensible and significant conceptual framework for confronting certain issues in science education. The framework takes the form of a scheme for analyzing science teaching materials, and the scheme is applied once, in a case study, to a single biology textbook. Although the investigator is well aware that, in studies of this kind, it is typical to seek independent corroboration of judgments made on the basis of any scheme for analysis, such corroboration was not sought. That the study is thus limited and, hence, exploratory needs further explanation.

The yield of this study, as stated earlier, consists of the scheme itself, results of the analysis, and reflective commentary on the use of the scheme. Independent corroboration of judgments may be considered appropriate for the first two of these; why this was not obtained is explained for each in turn below.

Development of the scheme requires that characteristics of different world hypotheses be abstracted from Pepper's work. Of course, independent corroboration could have been solicited to determine the extent of judges' agreement that appropriate portions of the work had been abstracted. This procedure would have been quite impracticable, simply because each judge would essentially have to go through the entire conceptualization process of the investigator (becoming thoroughly familiar with Pepper's work, etc.). An alternative has been chosen. The investigator has quoted very extensively from Pepper's work in both Chapter II and Appendix I, in order that the reader may have at hand the basis on which characteristics of world hypotheses are abstracted. While Chapter II is lengthy, it is a vital argumentative step in the study because it provides the reader with first-hand material from which to understand the investigator's reasoning in developing the analytical scheme.

Results of the analysis seem, at first glance, to be no more than the results of a classification procedure. If that were the case, independent corroboration could easily be sought for the investigator's judgments. However, to call the application of this analytical scheme an ordinary classification procedure would be to underestimate seriously what is involved. Chapter V details the subtleties required in applying the scheme, and points especially to problems of determining the unit of analysis (paragraph, sentence, phrase) and the context within which passages of the text are to be understood. Accordingly, an independent judge would have to master the contents of the entire textbook, and would also have to be coached by the investigator on how to "sense" the appropriate unit of analysis for each judgment. The first requirement is impracticable, and the second would invalidate the independence of judgment. Again, an alternative has been chosen. The investigator has provided a detailed, if lengthy, account of the analysis, including the basis for judgments made, in Chapter V and Appendix IV, so that the reader can trace the reasoning behind those judgments. In addition, substantial excerpts of the textbook itself are photoreproduced in Appendix V, so that the actual data are present for the reader to inspect.

In short, to solicit independent corroboration of judges for this study would have required that the study virtually be replicated by each judge. Instead, the investigator has elected to let the complexity of the study dictate the nature of the claim made in this thesis. The study is exploratory, and no claim is made for inter-rater reliability of the analytical scheme. Emphasis is upon conceptualization of a framework for systematically examining issues related to world view and the science curriculum. The case-study demonstration of that framework (analytical scheme) to detect messages projected about world view in science teaching materials is to demonstrate its significance, defensibility, and potential usefulness. The rigor of the analysis can be judged by the reader since data, basis for judgments, basis for developing the analytical scheme, and the scheme itself are all present within this document. Utilization of the scheme for independent corroboration by judges, or for analysis of other textbooks, would constitute quite another study.

Another sense in which the study is exploratory is that a systematic treatment of world view is assumed. This investigation does not actively enter substantive debate in philosophy, and no attempt is made to defend Pepper's philosophical thesis.[1] For example, it is assumed (after Pepper) that there are some six or seven world hypotheses and that others result from an eclectic treatment of the categories of these six or seven. Further, it is assumed, according to Pepper's claim, that each world hypothesis generates a theory of truth. Both of these assumptions provoke philosophical debate, of course. Problems with the analysis that can be attributed to Pepper's treatment are regarded as limitations of the scheme.

Significance of the Study

An adequate discussion of the significance of this study (Chapter III) must await the development of the analytical scheme in

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[1] This does not mean that Pepper's treatment is accepted uncritically; Chapter V reviews criticism of his work.

Chapter II, since concepts from the scheme are necessary for that purpose. Nevertheless, it is possible at this point to discuss briefly the significance of a study dealing with the complex relationships among world view, social issues, curriculum concerns, and the way in which teaching is conceptualized. The discussion is in three parts: world view as related to social issues, to curriculum, and to a concept of teaching.

World view and social issues

The significance of world view as a perspective for research in science education rests in part on the relationship between world views and social issues. It is reasonable to assume that the prevailing world view of a society influences the development of institutions and ways of doing things in that society. For instance, the development of technology in North America is intimately related to an esteem for science, which reflects the society's sense of reality.

The realization that this technology has shortcomings or unwanted byproducts, such as pollution, is commonplace. Moreover, in the past few years some social critics have turned their attention to more intangible concerns, for example the "psychic liabilities" of total commitment to a scientific world view. According to Maslow,

> The model of science in general, inherited from the impersonal sciences of things, objects, animals, and part-processes, is limited and inadequate when we attempt to know and to understand whole and individual persons and cultures. It was primarily the physicists and the astronomers who created the *Weltanschauung* and the subculture known as Science. . . . Only recently has it been demonstrated just how and where

> this impersonal model failed with the personal, the unique, the holistic.[1]

Some social problems stem, potentially at least, from the limitations of a scientific world view if adopted as the only way to explain phenomena. The psychic nature of the problems, although difficult to define, has been expressed by phrases such as "existential vacuum," "ontological anxiety," "pursuit of loneliness," and "experience of nothingness." Novak characterizes it thus.

> A modern, technological, urban environment is supposed to exemplify progress, but we lack the means to measure the physical and psychical discomfort, the uprootedness, the repression, and the ascetical routines imposed upon us by technical progress. Our educational system favors pragmatic, conventional, cognitive intelligence rather than creative, imaginative, and affective intelligence. The costs in alienation are hardly measurable.[2]

Underlying such positions is the clear suggestion that social phenomena are influenced by men's world views.

World view and curriculum

If we give credence to arguments of Maslow and Novak, among others, we see that personal and social consequences for students might result from the inculcation of world views in the curriculum. Within this context, how people acquire world views and how world views influence their self-image, their actions, their values, etc., are curriculum questions because they are relevant to understanding important consequences for the young.

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[1] Abraham H. Maslow, The Psychology of Science (Chicago: Henry Regnery Company, 1966), p. xiii.

[2] Michael Novak, The Experience of Nothingness (New York: Harper & Row Publishers, 1970), pp. 34-35.

Such questions are global. Before they can be treated effectively it is necessary to articulate a systematic conceptual framework which appears promising for examining the issues. That is the purpose of this exploratory study: it is an effort to break ground in a demonstrably important aspect of science curriculum research.

World view and a concept of teaching

A recurrent theme of analyses of the concept of teaching suggests that provision must be made for students to be aware of the bases for knowledge claims, if it is to be claimed that teaching is occurring. It follows that provision must be made in teaching for students to be aware of world hypotheses, since these are frameworks from which knowledge is constructed. Even though this study is concerned with developing a scheme for detecting projected world hypotheses in science teaching material, rather than arguing for teaching world hypotheses in the curriculum, part of the significance of the study concerns the benefit derived if teachers and pupils are aware of world hypotheses. Provoking such awareness is consistent with a number of analyses of teaching. Selected analyses are summarized here, beginning with the work of Paul Komisar.

Komisar distinguishes teaching from other activities, such as indoctrination, by showing that the "act" sense in which we use the word teaching covers three uses: learning-donor acts (e.g., drilling, showing), learner-enhancing acts (arousing interest, reducing anxiety), and intellectual acts. Intellectual acts are the substantive acts of teaching, and "it is not some kind of learning, but some form of awareness, which is the intended upshot in intellectual teaching acts. . . ."[1] Furthermore,

> intellectual acts are logically lucid in that the act is done not only with the intention of securing a certain 'uptake' (an awareness of some point), but also so as (a) to divulge to the student what the intention is and (b) to achieve his awareness by identifying the reasons given as the intelligible grounds for the point the students are to become aware of.[2]

Scheffler's analysis of "rule model" teaching also distinguishes between acts which provoke a student's awareness and those which do not.

> Teaching may be characterized as an activity aimed at the achievement of learning, and practiced in such manner as to respect the student's intellectual . . . integrity and capacity for independent judgment. . . . It differentiates the activity of teaching from such other activities as propaganda, conditioning, suggestion, and indoctrination, which are aimed at modifying the person but strive at all costs to avoid a genuine engagement of his judgment on underlying issues.[3]

Student awareness of "underlying issues," or the basis for knowledge claims, is an important feature of both of these analyses of teaching. Further, Munby's analysis of "intellectual independence" gives reasons for providing for students' awareness of the bases of knowledge claims. He distinguishes between teaching that provides for intellectual independence and that which provides for intellectual dependence.

> Teaching which provides for Intellectual Independence introduces pupils to the intellectual undergirding of knowledge claims, in

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[1] B. Paul Komisar, "Teaching: Act and Enterprise," in Concepts of Teaching: Philosophical Essays, ed. by C.J.B. Macmillan and T.W. Nelson (Chicago: Rand McNally & Company, 1968), p. 79.

[2] Ibid., pp. 79-80.

[3] Israel Scheffler, "Philosophical Models of Teaching," Harvard Educational Review, XXXV (Spring, 1965), p. 131.

> a way that is not available from teaching characterized as providing for Intellectual Dependence. The latter type of teaching leaves pupils quite unable to distinguish between valid and invalid claims about the world, let along quite unable to comprehend criteria used in establishing validity. So, these pupils can become intellectually tied to prevailing beliefs or the beliefs of individuals without being in a position to make rational and informed judgments about these beliefs.
>
> Not only can Intellectual Independence refer to potential outcomes of ways in which knowledge claims are presented, but also the construct can apply to more embracing propositions or assumptions, such as views of science and views of the world. For instance, science teaching might portray the world as totally describable in scientific terms. . . . But, unless pupils are presented with the message that this is one way of viewing the world, and unless the teaching shows the benefits and foundations of several ways of viewing the world, pupils cannot judge rationally between such views. So, this teaching would provide for Intellectual Dependence--it leaves pupils dependent upon their teacher for particular beliefs.[1]

Providing for intellectual independence requires, then, that a student be made aware of the bases for knowledge claims. Different knowledge claims, of course, arise at least in part out of different ways of viewing reality. It follows that, if teaching is to provide for intellectual independence, provision must be made for the student to be aware of issues related to world hypotheses. Making provision stems from what it means to teach rather than to indoctrinate or propogandize. The potential significance of teaching in such a way that students become aware of world hypotheses is discussed further in Chapter III.

Summary

This exploratory study is in response to the lack of conceptual frameworks in science education which are sensitive to issues concerning world view. The significance of this study lies in the fact that it presents a framework (analytical scheme) useful for conceptualizing the complex relationships among world view, social issues, curriculum concerns, and the way teaching is conceived. This investigator uses Pepper's treatment of world hypotheses as the basis of a scheme for detecting world views projected in science teaching materials. The scheme is used in the case-study, demonstrative analysis of a single biology textbook. The yield of the study consists of the analytical scheme, results of the analysis, and reflective commentary on the use of the scheme.

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[1] A. Hugh Munby, "The Provision Made for Selected Intellectual Consequences by Science Teaching: Derivation and Application of an Analytical Scheme" (unpublished Ph.D. thesis, University of Toronto, 1973).

We can now turn to the first argumentative step in the thesis, the development of the analytical scheme.

CHAPTER II

DEVELOPMENT OF THE SCHEME

Introduction

The analytical scheme developed in this study has six parts, corresponding to six world hypotheses: animism, mysticism, formism, mechanism, contextualism, and organicism. Each part of the scheme is a summary of the characteristics of a single world hypothesis, as explained below.

After some preliminary information is presented, the structure of this chapter parallels the structure of the scheme. A section is devoted to each of the six world hypotheses, and a table at the end of each section presents the portion of the scheme developed in that section. All six parts of the scheme are presented together as Appendix III, for ease in comparing characteristics of the six world hypotheses and for the reader's later convenience in examining the detailed analysis in Appendix IV.

Some General Comments

World Hypotheses can be separated into two parts. The first consists of (1) an argument for entertaining the notion of world hypotheses as a metaphysical concept (in part, an argument against logical positivism), and (2) the development of what Pepper calls the root-metaphor theory. The second part is Pepper's explication and examination of a number of alternative world hypotheses.

Importance of the root metaphor

As noted earlier, Pepper developed the root-metaphor theory to account for different schools of philosophy on the basis of common-sense metaphors that give rise to coherent systems of thought. Thus a root metaphor, or basic analogy, is associated with, and indeed is vital to, each world hypothesis (two examples: the root metaphor for mysticism is love, and for mechanism it is machine).

It is not crucial to the argument of the present study to discuss in detail Pepper's justification for the notion of world hypotheses and the associated root-metaphor theory. Nevertheless, it may be helpful for the reader to refer at this point to the overview of these two matters presented in Appendix I, as an introduction to Pepper's work and as a context for better understanding the remainder of this chapter.

Six (of eight) world hypotheses chosen

This study is based on Pepper's treatment of six world hypotheses: animism, mysticism, formism, mechanism, contextualism, and organicism. Actually, in World Hypotheses he mentions a seventh--the "generating substance" hypothesis--but it is not used by this investigator. Pepper's treatment is too brief to be useful here, and he points out himself that the historical and conceptual significance of the generating substance hypothesis is quite limited, when compared to the six he treats more extensively.[1]

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[1] Pepper, World Hypotheses, pp. 92-96.

In a later work Pepper developed still another: the "selectivism" hypothesis.[1] It is not used in the present study primarily because it incorporates elements of mechanism and contextualism and is therefore somewhat redundant. In addition, Pepper's explication of selectivism propounds it as his own world hypothesis, whereas he is intent on theoretical development and comparison in his original conceptualization in World Hypotheses. (In passing, it is interesting to note that the investigator finds selectivism--or a similar world hypothesis, such as Laszlo's "systems view"[2]--potentially more useful than any of Pepper's original six, to account for certain sections of the textbook analyzed. This matter is pointed out in the analysis and discussed in Chapter VI.)

The reader might be somewhat puzzled that animism and mysticism are included as parts of this analytical scheme; their very names betray that they would scarcely be projected in a science textbook. It should be recalled, however, that the investigator is developing a conceptual framework for the purpose of confronting certain broad issues in science education. Substantive linkages are established among world view, social issues, curriculum concerns, and a concept of teaching. This conceptual framework happens to take the form of a scheme for analyzing science teaching materials, so that its correspondence to at least one of the realities of science education can be demonstrated. Thus, while animism and mysticism would not be likely to be projected in a science textbook, still they assume special importance as conceptual tools for understanding the "anti-science" movement and phenomena alluded to in the comments of Maslow and Novak, in Chapter I. (For example, the current "creation/evolution controversy" in science curriculum is clarified greatly if one compares animism and mysticism with other world hypotheses. More about this point is found in Chapter III.)

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[1] Stephen C. Pepper, Concept and Quality: A World Hypothesis (Lasalle, Illinois: Open Court Publishing Company, 1966).

[2] Ervin Laszlo, The Systems View of the World (New York: George Braziller, Inc., 1972).

Significance of the preliminary analysis

Instrumental to the development of the scheme was a preliminary analysis using Pepper's treatment of each of the six world hypotheses as a guide. The material for analysis was selected on the basis of its intuited and fairly transparent suggestion of different world hypotheses; it was taken from written material other than science textbooks.

Initially, the reason for undertaking the preliminary analysis was to explore the feasibility of using Pepper's framework. The results were quite promising. Beyond that, however, the preliminary analysis served other useful functions. For an obvious one, it gave the investigator practice at applying Pepper's framework to written material. This not only helped in understanding Pepper's work more fully, but also indicated needed refinements in the investigator's application of it. (For example, reflections on the preliminary analysis shaped a refined notion of projection and similar considerations dealing with the nature of claims that can be made about world hypotheses implied by written material.) In addition, the preliminary analysis provided a guideline for the format used in the major analysis of the study. Finally, the preliminary analysis suggested refinements in the content of each portion of the analytical scheme itself.

Appendix II contains the entire preliminary analysis. It would not prove too helpful to read it at this point, however. At the close of each section dealing with a single world hypothesis, later in this chapter, the reader's attention is directed to the corresponding portion of Appendix II.

Mechanics of developing the scheme

In each of the following six sections, the portion of the analytical scheme corresponding to each world hypothesis is developed in the following manner. The investigator identifies in Pepper's work (1) the root metaphor (basic analogy), (2) the categories (basic concepts used for explanation and description), and (3) the theory of truth for each world hypothesis. These three characteristics, and any others that seem potentially useful as identifying features, are summarized to form the scheme, one hypothesis after the other.

As mentioned in Chapter I, the investigator has quoted extensively from Pepper's work, in order that the reader may have at hand the basis on which the characteristics of each world hypothesis are identified, and also in order to maintain the integrity of Pepper's work. The length of the various summaries is in direct proportion to the length of Pepper's explication of the several hypotheses.

Animism

The root metaphor of an animistic world hypothesis is man, and phenomena are accounted for by assuming that physical aspects of nature have a motivating force (such as "will") similar to that perceived in man. Pepper explains the personification of natural phenomena.

> The person of man expands very naturally over the universe by the process of personification, not to mention other similar, more vivid processes such as dreams and illusions. The result has been a certain crystallization of the root metaphor into what may be regarded as its most developed form in the notion of spirit.[1]

Pepper contends that it is difficult to specify a strict set of categories for animism because of the elusive nature of "spirit." However, he quotes Tylor as elucidating the essential animistic categories.

> To the lower tribes of man [writes Tylor], sun and stars, trees and rivers, winds and clouds, become personal animate creatures, leading lives conformed to human or animal analogies, and performing their special functions in the universe with the aid of limbs like beasts, or of artificial instruments like man; or what men's eyes behold is but the instrument to be used or the material to be shaped, while behind it there stands some prodigious but yet half human creature, who grasps it with his hands or blows it with his breath. . . . At its full development, this view includes the belief in souls and in a future state, in controlling deities and subordinate spirits. It culminates in the notion of the personal soul or spirit. . . .
>
> This personal soul or spirit is a thin unsubstantial human image, in its nature a sort of vapour, film or shadow; the cause of life and thought in the individual it animates; independently possessing the personal consciousness and volition of its corporeal owner, past or present; capable of leaving the body far behind, to flash swiftly from place to place; mostly impalpable and invisible, yet also manifesting physical power, and especially appearing to man waking or asleep as a phantasm separate from the body of which it bears the likeness; continuing to exist and appear to men after the death of that body; able to enter into, possess, and act in the bodies of other men, of animals, and even things.[2]

From this quotation it is possible to identify several characteristics of an animistic world hypothesis.

1. Non-human entities lead lives conforming to human or animal analogies.
2. There is a future state (existence).
3. There are controlling deities and subordinate spirits.

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[1] Pepper, World Hypotheses, p. 121.

[2] Ibid., pp. 121-122. (Brackets are Pepper's.) Pepper quotes this material from E.B. Tylor's Primitive Culture (London: Murray, 1915), Vol. I, pp. 285, 427, 429.

4. There are transcendent spirits which are the "life-blood" of the objects or individuals over which spirits control and animate.

A revealing characteristic of an animistic world hypothesis is the theory of truth that develops from it. Truth is ultimately determined by the spirit, and the spirit or its designate has absolute authority in matters of truth.

> The natural animistic theory of cognitive value is the authority of spirit. What a great spirit says is true, and what the greatest spirit says is most true. When the direct word of a spirit cannot be obtained--in his immediate presence, in dreams, in voices, in omens, in prognostications, in sacred traditions, or in holy books--then the word of the most authoritative representative of a spirit must be taken. So we come to the authority of shaman, medicine man, and priest. Animism is the natural metaphysical support of authoritarianism, which inevitably culminates in the dogma of infallible authority. It is ultimately infallible authority that is appealed to for rendering final and determinate the factual interpretation of the animistic world hypothesis.[1]

The root metaphor man, spirit, the four categories listed above, and the "infallible authority" theory of truth constitute the characteristics of an animistic world hypothesis. These are summarized in Table 1, which is the first portion of the analytical scheme. Once Table 1 has been examined, the reader will find that a richer understanding of the characteristics of animism results from reading through pages A11-A14 (in Appendix II), the first portion of the preliminary analysis. (It should be borne in mind that the preliminary analysis was undertaken before the final version of the scheme was developed.)

Mysticism

The root metaphor of mysticism is love. "The hypothesis states that this emotion is the substance of the universe, and that so far as

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[1] Ibid., pp. 122-123

TABLE 1

CHARACTERISTICS OF ANIMISM AS A WORLD HYPOTHESIS*

Categories and identifying features:	Comments:
A. Root Metaphor: MAN. SPIRIT	The personification of events in the universe culminates in a concept of spirit. Man is the primitive root metaphor. Spirit is the mature root metaphor.
B. Categories	
PERSONIFICATION	Non-human entities (wind. rain, trees, etc.) lead lives conforming to human or animal analogies.
CONTROLLING DEITIES and SUBORDINATE SPIRITS	Controlling and subordinate spirits are extensions of the personification of all entities and natural phenomena. Some phenomena control others (e.g., fire destroys trees) and therefore have more powerful spirits. Spirits are sometimes envisaged to be monstrous, half-human creatures.
TRANSCENDENT SPIRITS	Spirits are the "life-blood" of the objects and individuals they control. Spirits are often vaporous and have the ability to leave the object or organism which they inhabit. Spirits cause life, thought, and volition. Spirits can manifest physical power and exist after the death of the organism they inhabit.
FUTURE EXISTENCE	This follows from the transcendent nature of the spirit. After death the organism experiences a future existence.
C. Animistic truth	Truth lies in the authority of the spirit and is infallible. Greater truth is possessed by the more powerful spirit. Truth can come from the spirit's designate (shaman, medicine man, priest). A spirit's words can come from his immediate presence, dreams, voices, omens, holy books.

*Adapted from Stephen C. Pepper's *World Hypotheses* (Berkeley: University of California Press, 1942).

we differentiate things, these are generated from this substance and are ultimately nothing but this substance."[1]

The first three categories consist of principles by which the emotion of love acts on things in the universe:

1. degrees of intensity of emotion (the stronger the emotion, the more of it, and the more the reality),
2. degrees of fusion (the stronger the emotion, the greater the tendency for things to meld together and unify, and the greater the reality),
3. degrees of inclusiveness (the greater the number of things melded together, the greater the reality).

These three principles are manifested in a "feeling" for the emotional experience of love. This feeling can be characterized by four additional categories which explicate the quality of the emotional experience:

4. supremely cognitive and revelatory,
5. immediate and totally uninterpreted,
6. certain and indubitable,
7. emotionally ecstatic.[2]

The theory of truth associated with mysticism is integrally related to these categories. A mystical experience reveals the truth and is indubitable.

> The revelation of the experience is the truth (or the Truth), and all other cognitive claims are completely or partly false, apparent, and unreal. . . . The mystic is convinced of the supreme truth of

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[1] Ibid., p. 133.

[2] Ibid. The seven categories are abstracted from Pepper's treatment of mysticism. The first three are discussed on p. 133, the latter four on p. 128.

> his revelation. He takes his stand on the indubitable certainty of the experience and pays no particular cognitive attention to the other "facts" of the world.[1]
>
> Those "facts" are most real which are most intense in the beatific quality of the emotion of love, most completely fused and unified in that emotion, and most widely comprehensive in the inclusion of fact. By extrapolation, it follows that the most intense, completely fused, beatific, loving feeling of the whole wide world would be an intuitive experience of the whole of reality itself, and would be Truth itself. Such an experience one seems to have in the apical mystic experience, which is, moreover, sealed with the feeling of indubitable certainty.[2]

Table 2 presents the characteristics of mysticism. Once it has been examined, the reader is urged to turn to the second portion of the preliminary analysis (pages A14-A16 in Appendix II) for a more comprehensive understanding of this world hypothesis.

Formism

Formism has been called "idealism" or "Platonic idealism," and it "is associated with Plato, Aristotle, the scholastics, neoscholastics, neorealists, [and] modern Cambridge realists."[3] The root metaphor of formism is similarity, but the hypothesis consists of two versions.[4] This summary will follow Pepper's work by looking first at "immanent formism" and then at "transcendent formism."

Immanent Formism

Immanent formism originates from the common-sense notion that the world is full of many things which are just alike or similar. To illustrate this point, Pepper speaks of examining two identical yellow sheets of paper.

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[1] *Ibid.*, pp. 130-131. [2] *Ibid.*, p. 134. [3] *Ibid.*, p. 141. [4] *Ibid.*, p. 151.

TABLE 2

CHARACTERISTICS OF MYSTICISM AS A WORLD HYPOTHESIS*

Categories and identifying features:	Comments:
A. Root Metaphor: LOVE	Mysticism is the philosophy of love, peace, and unity. The emotion of love is the substance of the universe.
B. Operating principles of love	
INTENSITY	The stronger the emotion is, the greater the reality.
FUSION	The stronger the emotion is, the greater the tendency for things to fuse and be seen as generated from love.
INCLUSIVENESS	As the emotion becomes greater, more things are fused and there is more reality.
C. Quality of the experience	This refers to how the experience of love is felt by the individual.
SUPREMELY COGNITIVE	A mystical experience gives immediate knowledge and denies other modes of cognition.
IMMEDIATE AND UNINTERPRETED	Senses and imagination are not used. The experience comes through revelation.
CERTAIN	Cognitive certainty is intense in a mystical experience.
EMOTIONALLY ECSTATIC	The revelation has a beatific quality.
D. Mystical truth	Truth comes through the mystical experience. The greater the emotional experience is, the greater the truth revealed. The most intense experience reveals absolute truth.

*Adapted from Stephen C. Pepper's *World Hypotheses* (Berkeley: University of California Press, 1942).

> We now have two exactly similar objects before us, both together. We cannot tell them apart except for the fact that we see that there are two--one, let us say, to the right of the other. If it is important to be able to tell such objects apart, we generally put a mark on one of them so as to make them different. In other words, they are not different at all unless we make them so. This is a common enough experience. Now the mature root metaphor of the sort of formism which we may call "immanent formism" consists in simply describing this experience of two exactly similar objects minutely, and accepting literally the results of the description.[1]

Pepper describes the two pieces of yellow paper, noting that there are (numerically) two separate pieces of paper and that these two pieces participate in several qualities which are the same for them (the two pieces are identical). One of the more obvious qualities observed is color.

> There is one quality, yellow, in two particular manifestations. We see these conditions directly before our eyes, and there is nothing more obvious or certain in the world.
>
> If we accept this intuition at its face value, we have discovered that objects of perception like this have two aspects, particularity and quality, and that these two aspects are absolutely distinct even though we may never experience the one without the other. For we perceive two particulars (sheets of paper) with one quality (yellow).[2]

However, within this formistic framework there exist relationships among particulars. For example, if there are two pairs of identical papers placed side-by-side, then each of the pairs is similar to the other pair by virtue of their side-by-sideness. This side-by-sideness is called a relation and is a form just as quality is a form. It is convenient, therefore, to use a term which includes both qualities and relations. An appropriate term for this purpose is character, and the characterization of something is in terms of form, either quality or relation.

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[1] Ibid., p. 152. [2] Ibid., pp. 152-153.

> We thus obtain the following main categories for immanent formism: (1) characters, (2) particulars, and (3) participation. This last is the tie between characters and particulars. It is the particularization of a character, or the characterization of a particular. It has many names, and is often called "attribution" or "predication," referring to the fact that the grammar of our culture is dominated by these categories. "This is yellow" is a sentence epitomizing these three categories. "This" represents the uncharacterized particular; "yellow," the unparticularized character; "is," the participation of each in the other to produce the object.[1]

The relationship between these three categories of immanent formism is exemplified in the concept of class. Pepper states that "a class is a collection of particulars which participate in one or more characters."[2] Classes are arranged in a hierarchical fashion according to the number of participating characters. That is, as the classification becomes more specific there are a greater number of participating characters.

> We notice . . . that a class is itself neither a character, nor a particular, nor a participation, nor a separate category. It is simply the actual working of the three categories in the world. We simply observe that a character or a group of characters normally participates in a number of different particulars. We give a name to that observed fact and call it "class." Class is simply a name for a specific operation of the three immanent categories, an operation completely analyzable into the functioning of those categories. A class is, accordingly, a thoroughly real thing, but what is real is the functioning of the categories.[3]

Transcendent Formism

Pepper then turns to a discussion of transcendent formism in which the root metaphor comes from

> two closely allied sources: the work of the artisan in making different objects on the same plan or for the same reason (as a shoemaker making shoes, or a carpenter making beds), and the

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[1] Ibid., p. 154. [2] Ibid., p. 159. [3] Ibid., p. 162.

> observation of natural objects appearing or growing according to the same plan (as crystals, oak trees, sheep).[1]

As an example of the first case Pepper discusses making a pair of shoes. There is a plan or "ideal" and there are materials for fulfilling the plan.

> The plan appears as a norm which the shoes fulfill according to the skill of the artisan and the limitations of the available material. The norm may rarely be fulfilled. Deficiencies in the leather and in the skill of the artisan lead to variations in the shoes and discrepancies from the norm. The shoes made by the same plan come out more or less similar, and their similarity is due to the identity of plan, but the norm is usually not completely revealed in the shoes, but transcends them.[2]

Pepper discusses a similar situation in the case of natural growths.

> It is much the same with an oak tree. There is no artisan here. The dynamics of creation comes out of the acorn and tree itself. But there are evidences of a uniform plan which all oak trees apparently seek to approximate. Oak trees vary because of variations in their conditions of growth, because of unsuitability of soil, water, neighboring growths, or inheritance. So, few oak trees are permitted to grow normally and to exhibit the full potentiality of the oak. In one way or another they are distorted, and the norm of the oak transcends them.[3]

At this point there is enough information to outline the categories of transcendent formism.

> This root metaphor of plan and material also develops three categories which closely parallel those of immanent formism. The categories of transcendent formism are: (1) norms, (2) matter for the exemplification of the norms, (3) and a principle of exemplification which materializes the norms.[4]

Pepper then compares immanent and transcendent formism in an effort to fuse the two sets of categories and produce a generalized category system for the formistic world hypothesis. A comparison of the two shows that the second categories of both immanent and transcendent formism are consistent. "Particulars" and "matter for the exemplification of the norms" are, in effect, one and the same since concrete matter is certainly a particular; and, conversely, any given particular would also be matter. The third set of categories of the two types of formism are also similar in that they represent the connection between their respective first and second categories.

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[1] Ibid. [2] Ibid., p. 163. [3] Ibid. [4] Ibid.

As Pepper points out, the main difference between the two types of formism is between "characters" and "norms." Yet both are forms, despite their differences. To synthesize the two, Pepper introduces the ideas of existence and subsistence.

> By "existence" we shall mean primarily the field of basic particulars (the collection of all elements of the second immanent category), and secondarily such particulars with any characters they may participate in. The field of existence, then, is primarily the field of bare particulars, and secondarily the field of all basically particularized characters. A bare particular (that is, a particular with no characters at all) may be a sheer abstraction. It could not possibly be observed. . . . Concrete objects such as we perceive and handle are all in the field of existence as secondarily considered . . . and so we might call the field of existence thus secondarily considered the field of concrete existence.
>
> By subsistence we shall mean the field of characters and norms so far as these are not considered as participating or being exemplified in basic particulars. Whether in fact there are any characters or norms which are not particularized in basic particulars, is another issue with which we shall not concern ourselves. . . . However that may be, there is no question that, in terms of the formistic categories, characters and norms may be considered in abstraction from basic particulars, and the "relations" they have to one another may be studied.
>
> All these "relations" are, of course, ties of various sorts. And here is where it is possible to amalgamate norms with characters. Norms, as we pointed out, are complex in character and are definitely subsistent forms. A norm, therefore, such as a shoe or an oak must participate in characters--in shape, color, and so on. A norm, therefore, is a sort of particular. But it is not a basic particular, because it may not be fully particularized. It is a subsistent or second-degree particular. It is a subsistent entity which, as subsistent, participates in certain subsistent characters. Such

> participation is, of course, also a second-degree participation, and does not constitute concrete existence.[1]

This discussion of the relationship between norms and characters gives rise to Pepper's categories of a formistic world hypothesis:

> (1) forms consisting of characters and norms which may have second-degree participations with one another, (2) basic particulars, and (3) first-degree participations or exemplifications.[2]

Norms and Science

Before moving to the conception of truth embodied in this world hypothesis, it is helpful to engage in a more detailed discussion of "norms" as this concept is relevant to science.

> There is evidence that norms seem to be used or presupposed in much of the basic work of empirical scientists. The specimen of flower, or bird, or insect sought after by a biologist is not *any* member of the *class*, but the "good specimen" or *norm* of the species. The biologist seems to have a pretty definite idea of the *normal* habits and the *normal* appearance of his species, and even if what he offers as a description of the species is simply the average, this average is not a class, but a norm. A species seems to represent, at least often, a state of biological equilibrium in nature, a structural point of balance and stability, and as such it would be not a class, but a norm. Similarly with the forms of matter--molecules, atoms, electrons. These seem to be, at least often, treated by empirical scientists as norms of physical structure. It is often assumed that matter must take these forms. There are the ninety-two atomic elements. Matter in the atomic stage is expected to appear in one of these forms and not otherwise. . . . There seems to be plenty of apparently direct inductive evidence for norms exemplified in nature.
>
> In fact, every law of science may be so interpreted. Persons who accept the theory that there are laws of nature, and that the aim of science is to discover these laws, which nature "follows," seem (if their words do not belie them) to imply that these laws are norms which regulate (literally render regular) the occurrences of nature.[3]

Furthermore, the notion of natural laws as forms is intimately tied to the formistic interpretation of time, space, and causality.

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[1] *Ibid.*, pp. 167-168. [2] *Ibid.*, p. 170. [3] *Ibid.*, pp. 165-166.

Pepper argues that both time and space are forms which are easily construed as laws that nature "follows." Empirical laws of nature, then "participate in the forms of both physical time and space."[1]

> These constitute accordingly a basic restriction upon what characters can and cannot appear in concrete existence, and upon the order of their appearance. And still further restrictions are placed upon the order of concrete existence by natural laws. We come, in a word, upon *causality*.[2]

Causality in formism, according to Pepper, is the participation of norms in basic particulars through the forms of space and time. He gives the case of gravitation:

> Consider the law as it was conceived in the nineteenth century as a law distinct from the structural laws of time and space.
>
> We have then as concrete existences the masses of the earth and the lead ball. These are also characterized by their spatial relation to each other, their distance apart. They are also characterized by a temporal relation, the date at which the lead ball is dropped. Now all masses participate in the law of gravity. According to this law, these masses are, as we say, attracted to each other, which means that the law necessitates, in this case, the motion of the ball at a specified acceleration in a straight line to the earth. The law thus regulates the appearance of new characters of time and space relationships--new dates, distances, and velocities--which are given to the ball at each stage of its descent. These *changes* are determined by the law which applies to the ball as a concrete existent on account of its character, mass.
>
> The *causal* structure of a series of events is thus as follows: first, a basic particular (or set of basic particulars) having certain characters; second, the participation of these characters in a law, which itself participates in time and space characters; third, the determination, by the law, of other basic particulars as having certain dates or positions and as having certain characters the same as those possessed by the first basic particulars, or different from them. Causality is the determination of the characters of certain basic particulars by a law which is set in motion by the characters of other basic particulars which participate in that law. A law, in other words, is a bridge from one set of basic particulars to another set, determining the characters of one set by those of the other.[3]

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[1] *Ibid.*, p. 175. [2] *Ibid.* [3] *Ibid.*, pp. 176-177.

Correspondence theory of truth

The concept of truth associated with a formistic world hypothesis, according to Pepper, is the correspondence theory; it stems from the formistic notion of similarity. "Truth consists in a similarity or correspondence between two or more things one of which is said to be true of the others."[1]

> We may very simply define truth as the degree of similarity which a description has to its object of reference. It follows that a true description actually possesses the form of its object--within the limitations prescribed by the conventions of the description. Within the limitations of size and black and white, a charcoal portrait actually participates in the form of the sitter. . . .[2]

Pepper contends, however, that there are two types of truth in formism: historical and scientific. Historical truth refers to existence; its establishment consists of describing characteristics (qualities and relations) of particular events.

> There is no necessity in historical truths. The historian describes events as they have occurred. If he finds that they are causally related, he describes the causal relations as part of the existential events. But his interest is primarily in the character of the events that occurred, not in the laws which they may exemplify.[3]

Scientific truth is concerned with subsistence; its establishment "consists in descriptions of norms and laws."[4] Scientific truth is arrived at by induction; using induction the scientist moves from particular events to the laws which those events follow. But, according to Pepper, "the formist recognizes two types of inductions: (1) those yielding descriptions of empirical uniformities, and (2) those yielding descriptions of natural laws."[5] In the case of empirical uniformities, reliable predictions can be made without knowing why the uniformities hold. In the case of natural laws, regularities are seen as exemplifications of the laws.

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[1] *Ibid.*, p. 180. [2] *Ibid.*, pp. 181-182. [3] *Ibid.*, p. 182.

[4] *Ibid.* [5] *Ibid.*

> Descriptions of empirical uniformities thus lie midway between historical statements and scientific statements properly so called. They are statements of facts observed in concrete existence and, so far, are historical in nature. But as generalizations of regularities observed in these facts they have a scientific bearing. Yet as failing to exhibit the necessity for these regularities they are not completely scientific.
>
> From the point of view of a formist, statements of empirical uniformities are only half truths. Full truths are descriptions which accurately correspond with facts that have occurred or with laws that necessarily hold. Descriptions of empirical uniformities are simply rungs in the ladder from contingent fact to necessary law. They are signs of human ignorance. For if we know the whole truth about them we should know the law or the combination of laws which made their regularity necessary, or we should know that they were not necessary but were mere historical coincidences which have been mistakenly generalized and which cannot be relied upon for scientific predictions.[1]

This study is concerned with descriptions as they are expressed in propositions, and with analysis of how it is known that a proposition is true. In this respect Hospers adds further clarity to Pepper's analysis of the correspondence theory.

> Truth is correspondence. "A proposition is true if it corresponds with a fact"; for instance, if it is a fact that you have a pet leopard, and if you say that you have a pet leopard, your statement is true because it corresponds with the fact.[2]

The characteristics of formism are summarized in Table 3. After examining it, the reader will find it helpful to turn to the third portion of the preliminary analysis (pages A17-A23 in Appendix II) for an example of written material which projects formism.

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[1] *Ibid.*, p. 183.

[2] John Hospers, *An Introduction to Philosophical Analysis* (2nd ed.,; Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1967), p. 115.

TABLE 3

CHARACTERISTICS OF FORMISM AS A WORLD HYPOTHESIS*

Categories and identifying features.	Comments:
A. Root Metaphor: SIMILARITY	Observation of similarity gives rise to immanent and transcendent formism.
B. Immanent formism	Similar events or objects are described and the results of the description are accepted literally.
CHARACTERS	Characterization of things is in terms of quality or relation. Character, quality, and relation are all forms.
Quality	Color, size, shape, texture, luster, etc. are qualities of things.
Relation	"Side by sideness" is a relationship between two particular things.
PARTICULARS	These are numerical entities characterized by qualities and relations. Two aspects of objects of perception are particularity and character. These two aspects are distinct but never are experienced separately.
PARTICIPATION	This is the tie between characters and particulars. It is the characterization of a particular or vice versa. A class is a collection of particulars that participate in one or more characters. The basis for classification lies in the similarity of specimens to ideal forms.
C. Transcendent formism	The observation of similarity comes from two sources: goods made according to the same plan, and natural objects growing according to the same plan.
NORMS	A plan to make something is a norm which transcends the thing made, and natural growths develop according to a norm. In both cases, because of contingencies (available materials, skills of the artisan, natural conditions, etc.), the norm is not fully realized but transcends the material objects. Natural laws are norms which regulate the occurrences of nature. The aim of science is to discover the laws which nature "follows."
MATTER	Matter exemplifies the norms. This category parallels the second category of immanent formism—particulars.
PRINCIPLE OF EXEMPLIFICATION	This is the tie between norms and matter and materializes the norms. (This category parallels the third category of immanent formism—participation.)
D. Existence and subsistence	These concepts reconcile the first categories of immanent and transcendent formism. Since the second and third categories of both types of formism are compatible, reconciliation of the first categories produces "unified" formism.) Existence refers to particulars or matter. Primary existence refers to bare particulars which have no characters and therefore cannot be perceived. Concrete existence refers to particulars with participating characters (perceivable concrete objects). Subsistence refers to characters and norms not particularized. Characters and norms are both forms and are subsistently related.
E. Correspondence theory of truth	Truth is the similarity or correspondence between two or more things, one of which is said to be true of the others.
Historical truth	Truth concerns existence and consists of describing characteristics of particular events.
Scientific truth	Truth concerns subsistence and consists of descriptions of norms and laws. It is arrived at by induction.
Empirical uniformities	Empirical uniformities are half-way between contingent fact and necessary law. They do not show the necessity for regularities and therefore are not completely scientific.
Natural laws	Regularities necessarily follow from natural laws.

*Adapted from Stephen C. Pepper's *World Hypotheses* (Berkeley: University of California Press, 1942).

Mechanism

The root metaphor of mechanism is machine. This root metaphor includes both a mechanical and an electromagnetic theory of matter, giving rise to two different interpretations of a mechanistic world hypothesis. Either interpretation is, however, consistent with the mechanistic categories.

> Species of mechanism develop on the basis of the type of machine that is regarded as fundamental. A recent revolution in physics consisted largely in a shift from what is called a mechanical theory of matter to an electrical theory. This is really a shift from a lever to an electromagnetic field as the ultimate model of physical description. . . . The electromagnetic theory of matter is also in our terms a mechanism, provided it is accepted as a basic mode of description of fact and not interpreted in formistic or operational or other terms.[1]

Summary of categories

The historical development of mechanism begins with a traditional interpretation of a machine (action by contact), and it is from this that Pepper develops six categories applicable to both interpretations of mechanism:

Primary categories
1. Field of location
2. Primary qualities
3. Laws holding for configurations of primary qualities in the field (primary laws)

Secondary categories
4. Secondary qualities
5. A principle for connecting the secondary qualities with the first three primary or effective categories
6. Laws, if any, for regularities among secondary qualities (secondary laws).[2]

Pepper illustrates these categories by analyzing the action of a lever. He imagines a tree stump to be lifted by a man with the help of a long bar and a block of wood to act as a fulcrum. With a little experimentation the man can find positions for the lever, fulcrum, stump, and his body which will enable the stump to be lifted. The categories of mechanism can be illustrated with this basic example.

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[1] Pepper, World Hypotheses, p. 186.

[2] Ibid., pp. 193-194.

The first category (field of location) refers to the fact that the parts of the lever must be in some specific position in order for the machine to work.

> The lever is a configuration of parts having specified _locations_. . . . These locations determine the mode of functioning of the machine, and until these are specified there is no way of getting an exact description of the machine.[1]

The second category (primary qualities) emphasizes that the quantitative aspects of the machine are specifically relevant to the description of the way it works.

> We notice that the parts of the machine are all ultimately expressed in exact quantitative terms quite different from the objects as viewed in their common-sense guise. The rough old tree stump is taken only as a weight of kilograms, and so also is the exertion of my arm. So far as relevancy to the efficacy of the machine goes, the kilograms of these two parts are all that is needed. Such quantities as alone are relevant to the description of the efficient functions of a machine are historically called _primary qualities_.[2]

The third category refers to laws which exhibit the relationships of the primary qualities. In the case of the lever the law is stated quantitatively as

$$\frac{\text{X kilograms}}{\text{Y kilograms}} = \frac{\text{cm. from fulcrum to Y}}{\text{cm. from fulcrum to X}}.$$ [3]

Pepper discusses the equation after assuming that the lever is 300 centimeters long, the stump is located at one end while the arm pushes at the other, and the fulcrum is located two-thirds the way down the bar from the arm to the stump.

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[1] _Ibid_., p. 191. [2] _Ibid_., p. 192. [3] _Ibid_., p. 191.

> This equation exhibits the interrelation of the various parts of the machine in its action. For instance, the equation shows that if the parts of the lever have the configuration just suggested, the fulcrum being at the point 200 centimeters from the arm, then the pressure of the arm would need to be only 25 kilograms to raise and balance the tree stump of 50 kilograms. The equation, in short, describes an efficient law of action inherent in the structure of the machine.[1]

The fourth category (secondary qualities) refers to aspects of the machine which do not bear on its operation.

> To describe the machine in terms of centimeters and kilograms does not dispose of the qualities of the parts apparently irrelevant to the efficacy of the machine. The colors and textures and smells of the old tree stump, as well as the pleasantnesses and unpleasantnesses of these, still remain, as also my vivid feeling of exertion in my arm at my end of the lever and the pleasantness or unpleasantness there. These feelings and qualities in these parts of the lever have not disappeared. They are as vivid as ever and, even though not essential or even relevant to the effective action of the machine are not to be forgotten, for they are still in some way attached to the machine. Such qualities, which are observed in parts of a machine but are not directly relevant to its action, have been called secondary qualities.[2]

Pepper then describes the fifth category.

> Though these secondary qualities do not seem to have any effective bearing on the machine, they seem nevertheless to stick around it by some principle, and if we were to make a complete description of the machine we should want to find out and describe just what that principle was which kept certain secondary qualities attached to certain parts of the machine.[3]

Finally, the sixth category deals with statements of regularity (laws) concerning relationships among secondary qualities.[4]

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[1] *Ibid.*, p. 192. [2] *Ibid.*, pp. 192-193. [3] *Ibid.*, p. 193.

[4] *Ibid.* It should be noted that the six categories can be generalized to provide an account of the universe as a cosmic machine.

Inferred reality

This brief explanation of Pepper's six categories of a mechanistic world hypothesis serves as a focus for a more detailed discussion of two interpretations of mechanism (discrete mechanism, corresponding to a mechanical theory of matter, and consolidated mechanism, corresponding to an electromagnetic theory of matter). Before turning to a discussion of the two interpretations of mechanism, it is helpful to highlight aspects of the relationship between the primary and secondary categories. Especially notable is the fact that, although the primary categories give the actual or "real" description of the way a machine works, that "reality" is inferred rather than observed directly. Pepper states that, ultimately,

> our cognitive evidence for the structure and details of the cosmic machine described through the primary categories comes entirely from materials within the secondary categories. The more detailed the development of the primary categories the more obvious this fact becomes. And, on the other side, it turns out that the very conception of the secondary categories depends upon their contrast with the primary categories, so that any attempt to develop the former without the latter defeats itself, that is, implies what it denies.[1]

Since the first three categories (primary categories) are the most important in a mechanistic hypothesis, the discussion of discrete and consolidated mechanism centers on these. A brief examination of the secondary categories and the mechanistic theory of truth then follows. The discussion of discrete mechanism is more detailed than that of consolidated mechanism because the former historically precedes the latter and gives rise to the mechanistic categories.

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[1] Ibid., p. 195.

Discrete mechanism

As indicated by the name, one hallmark of discrete mechanism is the notion that structural aspects of the universe (e.g., atoms) are separate and distinct from each other.

> So space is distinct from time, the primary qualities are distinct from the field of locations, each primary quality is perhaps distinct from every other, certainly every atom (i.e., localized group of primary qualities) is distinct from every other atom, has an independence of its own, and every natural law (such as the law of inertia, or the law of action and reaction) is distinct from every other law, and distinct, moreover, from the field of locations and from the atoms distributed over the field.[1]

Further, there is the idea that, because of the total independence of the parts of the cosmic machine, anything could have been otherwise and it is only accidental that things are as they are. This idea tends "to be pushed farther and farther back into the basic structure of the universe, which is looked upon as purely and utterly irrational. . . ."[2] Another identifying characteristic of mechanism is the assumption that once the original structure of the universe is given, then the rest inevitably follows. This is the expression of determinism in a mechanistic world hypothesis.

> Almost everything is independent of almost everything else. If this atom had happened to be somewhere else at another time (and there is no necessary reason why it might not have been), then it would not have been hit by that atom; or if instead of the law of inertia for unaffected bodies there were a law of acceleration or deceleration (which might well have been), then also this collision would not have occurred. But since this atom did happen to be at this place at this time and had been obeying the law of inertia, it was inevitable that the collision should have occurred.[3]

The fundamental category of discrete mechanism is the field of location.

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[1] *Ibid.*, p. 196. [2] *Ibid.*, p. 197. [3] *Ibid.*, p. 196.

> Whatever can be located is real, and is real by virtue of a location. What cannot be located has an ambiguous reality until its place is found. . . . In mechanism, as its proponents are fond of reiterating, "only particulars exist." Moreover, these particulars of mechanism are not the bare or basic particulars of formism, but the structural particulars of space and time loci.[1]

And, in discrete mechanism, space and time are discrete, unrelated concepts.

> Space was thought of as a cubical room infinitely expanded in all directions. In this infinite or absolute space were absolute locations. And it was the particularization of a thing in one of these locations or in a line, or path, or volume of these locations that certified its reality.
>
> . . . .
>
> To this absolute space of externally related locations was gradually added an absolute time similarly conceived as an infinite one-dimensional manifold of externally related dates. The dimension of time was not even at first amalgamated with the three dimensions of space. Space was rather conceived as traveling intact like a freight car along the track of time. Thus one could have the identical space location at different times. Space, in other words, was external. It was changeless though it did move bodily from date to date.[2]

The primary qualities in discrete mechanism are size, shape, motion, solidity, mass, and number. These primary qualities are "the ultimate differentiating characters of the ultimate physical particles. . . ."[3] The idea of ultimate physical particles is characteristic of discrete mechanism.

> The traditional discrete mechanism is the theory of the atoms and the void, or, as the view develops, the theory of elementary particles distributed in space and time. The particles are regarded as elementary because they are the smallest pieces of matter into which bodies can be broken up.
>
> . . . .
>
> In the older theories, it was assumed that the atoms, or ultimate particles of physical analysis, were indestructible and therefore

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[1] *Ibid.*, p. 197-198. [2] *Ibid.*, pp. 198-199. [3] *Ibid.*, p. 204.

> eternal, and therefore described continuous paths in time from the infinite past to the infinite future.[1]

Pepper points out that, within discrete mechanism, Laplace reveals the deterministic nature of the laws that hold among the primary qualities.

> If we know the configuration of matter in the whole universe at any one time, he [Laplace] said, and the precise laws of matter, or if we know the configurations of matter at two times, so that we could deduce the laws which led from one configuration to the other, then we could deduce the configurations of matter for any other times whatsoever.[2]

The laws to which Laplace refers are Newton's three laws of motion and his law of gravitation.

> These laws, it will be seen (exactly these laws for Laplace, these or similar laws for other mechanists) constitute the dynamic element in the mechanistic universe. The field itself is static and undifferentiated. Even when the field is dotted with masses, it still lacks efficacy. The dynamic structure of nature comes from the laws which connect the masses together and guide them from one configuration to another.[3]

However, the status of laws in discrete mechanism is unclear for it seems that laws have a transcendent existence which would imply that they are forms. According to Pepper, a discrete mechanist insists that only particulars exist, and particulars exist only if they can be located in time and place. Even so, the ontological status of the laws remains a weak point in the mechanistic categories.

> Thus mechanism dissolves into formism, and all its categories vanish to be reinterpreted in terms of the categories of formism. . . . The only way of avoiding this mechanistic catastrophe is to imbed the primary qualities and the laws firmly in the spatiotemporal field. Things are real only if they have a time and place. _Only particulars exist_. . . . If this implication is realized, one sees at once that in a mechanistic nature there can be no alternatives,

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[1] _Ibid_., pp. 201-203. [2] _Ibid_., p. 208. [3] _Ibid_., p. 210.

> and that for mechanism statistical laws are not laws of nature in any ultimate sense, but only human constructions symbolizing to some approximation the actual interrelations of nature.[1]

Consolidated mechanism

Much that has already been said about discrete mechanism also applies to consolidated mechanism. One of the major differences in the two interpretations lies in the field of location. For discrete mechanism time and space are separate; for consolidated mechanism they are interrelated.

> A location is not regarded as established unless you know not only the three determining spatial measurements, but also the date or time at which these measurements are made.[2]
>
> The chief modern impetus for consolidation comes, of course, from relativity theory, for this has to do with the details of the spatiotemporal field. . . . Within certain limits, space and time are ambiguous until one establishes a reference system. . . . Time is thereby drawn right into space and the field is unquestionably consolidated.[3]

A second major difference lies in the primary qualities. Mass is the only differentiating quality for consolidated mechanism. Size, shape, motion, number, and solidity "are structural relations of the field in relation to the one and only truly differentiating quality, mass."[4]

Mass as a primary quality plays an important role in consolidated mechanism.

> The general theory of relativity . . . amalgamates the gravitational field with the spatiotemporal field. For gravitation is a phenomenon of mass, which is a primary quality, a pivotal differentiating quality. But more important still, this gravita-

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[1] Ibid., pp. 210-211. [2] Ibid., p. 200. [3] Ibid., p. 213. [4] Ibid. p. 205.

> tional mass is interpreted in terms of a gravitational field, which has the effect of amalgamating the law of gravitation into the first category, so that the field is no longer just the spatiotemporal field but the spatiotemporal-gravitational field.[1]

Further consolidation takes place with the use of the electromagnetic field. "The qualities of electric charge and of magnetic attraction are absorbed in the electromagnetic field laws, and these laws operate directly in the spatiotemporal field."[2]

Finally, consolidated mechanism provides further clarification of the status of laws and allows a more complete development of the idea of determinism.

> Electrons, positrons, neutrons, and the like must not, however, be conceived of in terms of particles like Lucretian atoms, but as structural modifications of the spatiotemporal field, the paths of which can be mapped out and expressed in that symbolic shorthand which we call descriptive laws. Strictly speaking, there are no laws in consolidated mechanism; there are just structural modifications of the spatiotemporal field. And no primary qualities, either, for these are resolved into field laws, which are themselves resolved into the structure of the field.
>
> So now, at last, only particulars exist, or more truly still, only a particular exists, namely, the consolidated spatiotemporal-gravitational-electromagnetic field. . . . This is . . . a fully determined field. The Laplacean ideal applies to it more fully than it ever applied to Laplace's world. For there might have been a slip between Laplace's configuration of masses and his laws, but in this world the laws and the masses *are* the structure of the field itself. . . . There is obviously no place in this world for statistical laws except as convenient symbolic instruments for prediction in place of the actual knowledge of field structures.[3]

Special importance of the secondary categories

The secondary categories are important in a mechanistic world hypothesis because it is only through the secondary categories that the workings of a cosmic machine can be inferred. Human perception is the perception of secondary qualities. "What we experience are secondary qualities only, from which as evidences we infer the mechanical efficient structure of the universe."[1] An important issue is the nature of the relationship between secondary qualities (things we can see, feel, hear, taste, smell) and the mechanical structure of the primary categories (field of location, primary qualities--mass, size, shape, etc. of elementary particles--, and laws). Pepper maintains that there have been three prominent theories as to the nature of this relationship.

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[1] *Ibid*., p. 213. [2] *Ibid*., pp. 213-124. [3] *Ibid*, pp. 214-125.

> There have been traditionally three main theories of the connection between the secondary and the primary qualities, namely, identity, causation, and correlation. The first of these we can rule out at once, even though it is still not uncommonly resorted to. Color and sound, for instance, are not literally electromagnetic or air vibrations, nor even neural activities. They are irreducible qualities. Causation can also be ruled out, if by causation is meant any of the efficient features of the primary categories. . . . The laws of motion, in the electromagnetic-field laws, describe masses and charges and have no application to such qualities as colors and sounds. Some sort of correlation is all that is left, that is, the observation that upon the occurrence of certain configurations of matter certain qualities appear which are not reducible to the characters of matter or the characters of the configurations.[2]

The sixth category of mechanism deals with secondary laws which express regularities among secondary qualities. In this context Pepper discusses secondary laws that appear to be operating in a discrete mechanistic human psychology.

> Complex mental states are regarded as analyzable without residue into mental elements of a relatively small number of kinds: sensations of color, sound, taste, smell, various sorts of tactile sensations, feelings such as pleasantness and unpleasantness, and possibly a few other elements. . . . It is sometimes suggested

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[1] Ibid., p. 216. [2] Ibid., pp. 216-217.

> that the laws of association are distinctively mental laws operating upon those elements to produce the more complex mental states.[1]

Pepper then points out one of the hallmarks of a mechanistic world hypothesis, which is a reductionist attitude that ultimately observables in the secondary categories can be reduced to non-observables in the primary categories.

> Often, however, the laws of association are regarded as simply the introspective manifestations of physiological laws, which may be regarded as complex operations of mechanical laws, so that the efficient side of the secondary qualities is referred outward into the physical world, into the primary categories of the cosmic machine.[2]

Causal-adjustment theory of truth

Three theories of truth have been commonly associated with a mechanistic world hypothesis. Two of these are more traditionally linked with other world hypotheses and so will not be treated at this point (correspondence theory, associated with formism, and pragmatic theory, associated with contextualism). The theory of truth that Pepper associates with mechanism is called a causal theory.

> The nominalistic theory of abstract and general terms was the regular mechanistic means of combating the arguments of the formists for the reality of forms and the category of subsistence. Says the traditional mechanist, a form such as blueness or bluejay is nothing but a word which stands for a number of objects. There is no form of bluejay, but there is the word which we have conventionally learned to use in reference to a number of physical objects.[3]

This position is carried further by holding that a name is a reaction to a particular stimuli.

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[1] Ibid., pp. 218-219. [2] Ibid., p. 219. [3] Ibid., p. 226.

> In principle it is exactly the sort of thing that happens when an organism reacts positively to food stimuli and negatively to prick stimuli. It is simply specificity of response in an organism carried to a higher degree of refinement. Instead of stepping on a nail and negatively reacting to the direct prick, an organism learns to react negatively to the visual stimulus of the nail associated with an original direct prick, and then learns to react negatively to the word "nail" associated with the visual stimulus which is associated with the original prick. All this is simply a complicated chain of physiological reactions, the whole sequence being explicable in physiological terms. And what is explicable in physiological terms is, as we have seen, theoretically explicable in physiochemical terms and can be amalgamated with the spatiotemporal field and the primary categories generally.
>
> Now, a sentence or scientific formula physiologically interpreted is nothing but a combination of such reactions or conditioned reflexes. The whole thing can be causally interpreted. Suppose my organism on the stimulus of light rays impinging on the retina of my eye responds with the articulate words, "That is a sharp nail." Suppose I wanted to find out whether that was a true response. What would I do? I would work back to the original reaction which conditioned the whole train of reactions of which the foregoing sentence is the last term. In other words, I would tentatively step on the nail, and if I reacted negatively I would say that the sentence was true; if not, I would say that it was false and look about for the causes which had produced the illusion.[1]

Pepper calls this the causal-adjustment theory of truth and contends that it is an attempt to bridge the gap between the observable secondary qualities and the inferred primary structure of the cosmic machine.

> The secondary qualities are correlated with the physiological configurations which are the effective structures of the attitudes mentioned. These physiological configurations are in the effective spatiotemporal-gravitational-electromagnetic field. They are part of this cosmic field and therefore reflect its structure directly. The effects of this field structure are immediately reflected in terms of the secondary qualities correlated with the physiological configurations. We thus learn about the structure of the great machine by a sort of detective work. We note the changes among our private secondary qualities, infer their correlations with the physiological configurations which are in our organism, and thence infer the structural characters of the surrounding field from its effects upon the configuration of our organism.[2]

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[1] Ibid., pp. 226-227. [2] Ibid., pp. 228-229.

Table 4 contains a summary of the characteristics of mechanism as a world hypothesis. The reader is urged, after examining Table 4, to read the fourth portion of the preliminary analysis (pages A23-A29 in Appendix II), for an example of written material which projects mechanism.

Contextualism

According to Pepper, the root metaphor of contextualism is the historic event as this term is used to refer to the active present.

> By historic event . . . the contextualist does not mean primarily a past event, one that is, so to speak, dead and has to be exhumed. He means the event alive in its present. . . . The real historic event, the event in its actuality, is when it is going on now, the dynamic active event. We may call it an "act,". . . . But it is not an act conceived as alone or cut off that we mean; it is an act in and with its setting, an act in its context.[1]

In identifying the categories of contextualism, Pepper points out unique features of the hypothesis which are ideas of change and novelty. Change and novelty form the basic categories of contextualism and through these categories the hypothesis asserts that there is no such thing as permanent and absolute structures in nature.

> The categories must be so framed as not to exclude from the world any degree of order it may be found to have, nor to deny that this order may have come out of disorder and may return into disorder again--order being defined in any way you please, so long as it does not deny the possibility of disorder or another order in nature also.[2]

Pepper then gives a brief overview of how he proposes to examine these and further categories of contextualism.

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[1] *Ibid.*, p. 232. [2] *Ibid.*, p. 234

TABLE 4

CHARACTERISTICS OF MECHANISM AS A WORLD HYPOTHESIS*

Categories and identifying features:	Comments:
A. Root Metaphor: MACHINE	Discrete mechanism accounts for the mechanics of a watch. Consolidated mechanism accounts for a dynamo.
B. Primary categories	Primary categories describe the way a machine works and give insight into its reality. (Primary categories below are listed according to discrete and consolidated mechanism.)
1. Discrete mechanism	Structural features of the universe are distinct (e.g., space, time, mass, number, motion, etc. are unrelated concepts). Action is by contact. Because all structures in the universe are independent, anything could have been otherwise. The universe accidentally is as it is. However, once the structures are given events inexorably follow. Statistical laws are not really laws, but are approximations to reality.
FIELD OF LOCATION	Parts of a machine must have spatial location for the machine to work. An exact description of a machine specifies the location of the parts. Things are real by virtue of a location. Nothing exists without a location in space and time.
PRIMARY QUALITIES	These refer to quantifiable aspects relevant to the efficient functions of a machine. Primary qualities ultimately reduce to differentiating qualities of particles distributed in time and space (size, shape, motion, solidity, mass, and number).
PRIMARY LAWS	These laws (e.g., F=MA) determine the configuration of elementary particles in time and space.
2. Consolidated mechanism	Recent advances in physics (especially relativity theory) collapse a number of discrete mechanistic categories. Action can be at a distance. There are no statistical laws. The universe is completely determined since the only existing particular is the spatiotemporal gravitational electromagnetic field.
FIELD OF LOCATION	The field of location is the spatiotemporal field.
PRIMARY QUALITIES	Mass is the only differentiating quality. General relativity theory consolidates the gravitational field (a phenomenon of mass) with the spatiotemporal field. The electromagnetic field law (involving the qualities of electric charge and magnetic attraction) operate in the spatiotemporal field.
PRIMARY LAWS	Descriptive laws are shorthand for structural modifications of the consolidated spatiotemporal-gravitational-electromagnetic field (the only existing particular).
C. Secondary categories	These refer to qualities that have no bearing on a machine's operation. The descriptive reality of a machine (lying in the primary categories) is inferred from secondary categories (human perception is of secondary qualities). Mechanistic reductionism is the explanation of secondary qualities in terms of primary categories (e.g., explaining mental events in terms of physiological processes).
SECONDARY QUALITIES	These are aspects of the machine perceived by individuals (e.g., color, texture, odor, sound, etc.).
PRINCIPLES OF CONNECTION	These elucidate the relationship between secondary qualities and primary categories. Three theories about the connection between primary and secondary categories are identity, causation, and correlation.
SECONDARY LAWS	These laws show the regularity of the relationships among secondary qualities. Laws of association in human psychology can be considered secondary laws.
D. Causal-adjustment theory of truth	Statements are manifestations of physiological responses to stimuli. Truth is adjustment of physiological attitudes to the organism's environment and is ultimately explained by causal relationships among primary qualities. In discrete mechanism the nature of adjustment seems to imply a correspondence theory of truth. Consolidated mechanism seems to imply a pragmatic theory of truth.

*Adapted from Stephen C. Pepper's *World Hypotheses* (Berkeley: University of California Press, 1942).

> Our procedure in developing the categories of contextualism will be as follows: First, to point out that in this theory nothing shall be construed as denying that anything may happen in the world. Thus *change* and *novelty* accepted in the most radical sense will be regarded as the fundamental presuppositions of this theory. But, second, to note that we have to deal with the world as we meet it, and we meet it only in the events of the epoch in which we are living. The events of our epoch seem to exhibit a structure which may be regarded as relatively uniform, and the basic concepts for this structure may be taken as *quality* and *texture*. We shall therefore regard quality and texture as the basic categories of contextualism for our epoch. That is, they will be regarded as the basic categories subject to the general proviso above mentioned regarding change and novelty.
>
> Third, we shall elaborate what is meant by quality and texture by means of a number of subheadings under each. Under quality we shall consider (1) the *spread* of an event, or its so-called specious present, (2) its *change*, and (3) its degrees of *fusion*. Under texture we shall consider (1) the *strands* of a texture, (2) its *context*, and (3) its *references*. Among these references we shall further note the following sorts: (a) linear, (b) convergent, (c) blocked, and (d) instrumental. This system of concepts may be regarded as a set of working categories for handling the events of our epoch. This system may be differently framed. Some contextualists (those who call themselves instrumentalists) are particularly interested in the instrumental references and subordinate all the other categories to these. This is possible. There are many ways of framing a set of working categories for contextualism. I do not claim any other virtue for this set except its balance and clarity for the purpose of our present rapid exposition.[1]

The categorial hierarchy of Pepper's treatment of contextualism has the following outline:

A. change

B. novelty

C. quality

    1. spread
    2. change
    3. fusion

D. Texture

    1. strands

---

[1] *Ibid.*, pp. 235-236

2. context
3. references
    a) linear
    b) convergent
    c) blocked
    d) instrumental.

With change and novelty classified as fundamental presuppositions of contextualism, it is now appropriate to examine quality and texture, the basic categories "for our epoch."

Pepper contrasts quality and texture as a preface to a more detailed discussion of the two categories. He begins by analyzing the writing of a trivial sentence: A period will be placed at the end of this sentence. This sentence is taken as the historic event, that is, the dynamic active event, or act.

> Now what is quality and what is texture in this event? Its quality is roughly its total meaning, its texture roughly the words and grammatical relations making it up. Generalizing, the quality of a given event is its intuited wholeness or total character; the texture is the details and relations which make up that character or quality.[1]

It is helpful to note that, as an event, Pepper is concerned with the writing of the sentence. This gives insight into the particular way in which the root metaphor of contextualism is to be understood.

> To give instances of this root metaphor in our language with the minimum risk of misunderstanding, we should use only verbs. It is doing, and enduring, and enjoying: making a boat, running a race, laughing at a joke, persuading an assembly. . . . These acts or events are all intrinsically complex, composed of interconnected activities with continuously changing patterns. They are like incidents in the plot of a novel or drama. They are literally the incidents of life.[2]

In making the distinction between quality and texture, Pepper emphasizes that the two are inseparable in any event. Therefore it is inconceivable that there could be an event with quality but no texture, or vice-versa.

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[1] Ibid., p. 238. [2] Ibid., pp. 232-233.

> There is no such thing as a textureless quality or a qualityless texture. It follows that contextualism denies that these are absolute elements. It denies that a whole is nothing but the sum of its parts. It even denies that a whole is a sort of added part like a clamp that holds together a number of blocks. A whole is something immanent in an event and is so intuited, intuited as the quality of that very event.[1]

Quality

Pepper considers three subcategories in his analysis of the quality of an event. First, the quality of an event has a spread: the temporal present has connections both with the future and with the past. Pepper again uses the writing of a trivial sentence to discuss spread (A period will be placed at the end of this sentence).

> As I am writing, A period will be placed at the . . . , my act is rather thick in its duration and spreads, as we say, forward and back. I lift my pen at "the" and am just about to put down "end." The word "end" is not yet down, but it is being reached for and its meaning is already largely taken up in what has preceded. This forward reach in the quality of an event is the feeling of futurity.
>
> There is a corresponding feeling of pastness which draws into the quality all the preceding words of the sentence. Even if I am saying the sentence and not writing it, so that I have not the assistance of the spatial line of words, still the word "period" is drawn from the past as I utter "the." That is to say, the word "period" is active now in the quality of this event, even though it is mathematically past.[2]

The notion of spread in the quality of an event is closely related to the contextualistic concept of time. The term "present" for a contextualist includes the concept of spread and therefore entails connections with the past and future. "What is present in an event is whatever contributes directly to its quality."[1] For a contextualist, however, the intuited event cannot be analyzed using a linear concept of time.

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[1] Ibid., p. 238. [2] Ibid., pp. 239-240.

> For the contextualist, the dimensional "time" of mechanism is a conceptual scheme useful for the control and ordering of events, but not categorial or, in that sense, real. The scheme is useful in this event to describe the order of the words. "Period" is the second word, "end" the eighth, and "the" the seventh. Taking the word I am writing as the schematic present, then "period" is quite a little past and "end" is in the immediate future. But if a mechanist goes on to argue that accordingly the only word actually existing in the present is the word I am writing, "the," the contextualist flatly contradicts him with his intuition of the spread of the present quality of the event.
>
> If it is objected that this is equivocating in the word "present," the contextualist declares that he has as much right to the word as the mechanist. In common sense the word is ambiguous. On refinement we discover that it means either the event actually going on or a point in a dimensional scheme. Call the one the "qualitative present" and the other the "schematic present," and the equivocation and much of the paradox is resolved.
>
> But the basic issue will not be resolved, because it is a categorial issue between mechanism and contextualism. Mechanistically inclined people . . . will continue to try to "clarify" the fact by reducing the intuited spread to the terms of a dimensional scheme. They will try to show that the qualitative present is nothing but a confused way of saying something that is much more clearly expressed in terms of schematic points or slices along a line. There is no denying the clarity of schematic time. According to the contextualist, its clarity is the reason for its invention. But this particular mode of clarity, he insists, distorts the qualitative fact, and is no substitute for the fact. And since the issue respecting whether or not there is such a distortion is a categorial issue, it cannot be settled by a simple confrontation of fact. It takes something more than the clarity of an expression to convince the contextualist that his intuition of the qualitative spread of a present event is fictitious.
>
> So, the contextualist is careful to distinguish between qualitative time (often called "duration") and schematic time. For him the former is categorial and the latter derivative. He does not deny the utility of the latter, but he denies its adequacy to reveal the nature of an actual event. In an actual event the present is the whole texture which directly contributes to the quality of the event. The present therefore spreads over the whole texture of the quality, and for any given event can only be determined by intuiting the quality of that event.[2]

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[1] Ibid., p. 240. [2] Ibid., pp. 240-242.

Change is the second category of quality of an event. Change refers to the altered appearance of qualities when observed from different perspectives.

> This change goes on continuously and never stops. It is a categorial feature of all events; and, since on this world theory all the world is events, all the world is continuously changing in this manner. Absolute permanence or immutability in any sense is, on this theory, a fiction and its appearance is interpreted in terms of historical continuities which are not changeless.[1]

Fusion refers to the notion that the individual textures of an event are coalesced to form a whole quality. Pepper gives William James's somewhat famous example of the quality of lemonade. The individual textures of sugar, water, and lemon are fused to form the quality of lemonade. The extent of fusion in this case is so great that it is (nearly) impossible to distinguish the individual textures. If, however, the textures are taken separately, then each has its own quality which is the fusion of still other textures.

> Where fusion occurs, the qualities of the details are completely merged in the quality of the whole. Where fusion is relaxed, the details take on qualities of their own, which may in turn be fusions of details lying within these latter qualities.[2]

Furthermore, Pepper points out that the degree of fusion can vary from one quality to another.

> Occasionally . . . an event is completely fused, as in a mystic experience or an aesthetic seizure. But generally there is some degree of qualitative integration in an event, in which case the fusion of the event quality is relaxed and the qualities of the details of the texture begin to be felt in their own right though still as within the quality of the event. Such qualitative integration may pass through several levels in a single event with varying degrees of fusions at the different levels.[3]

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[1] Ibid., p. 243. [2] Ibid. [3] Ibid., p. 244.

Texture

As noted earlier, texture is broken into subcategories as follows:

1. strands
2. context
3. references
    a) linear
    b) convergent
    c) blocked
    d) instrumental

Pepper points out that it is more convenient to analyze texture, strands, and context in such a way as to show their interrelatedness.

> A texture is made up of strands and it lies in a context. There is, moreover, no very sharp line between strands and context, because it is the connections of the strands which determine the context, and in large proportion the context determines the qualities of the strands. But by way of definition we may say that whatever directly contributes to the quality of a texture may be regarded as a strand, whereas whatever indirectly contributes to it will be regarded as context.[1]

Pepper demonstrates the nature of the relationship of texture, strand, and context with the following analysis.

> Let us write out our sentence once more: A period will be placed at the end of this sentence. Let us keep the event quality somewhat diffused so that the articulations of the sentence into phrases and words will be felt. Then let us take the phrase "at the end" for consideration. This phrase with the other three ("A period," "will be placed," "of this sentence") are details of the total sentence with integrated meanings or relatively fused qualities of their own and as such are textures in their own right. They are textures defined by the fused meanings of the phrases.
>
> Now, with the phrase "at the end" taken as a texture, we may roughly say that its strands are "at," "the," and "end," and that its context is the other three phrases of the sentence. The meanings of "at," "the," and "end" contribute directly to the total meaning of the phrase. But the total meaning of the phrase depends also on the connections of these strands with outlying words and phrases which indirectly enter into the meaning of the phrase and constitute its context.[2]

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[1] Ibid., p. 246. [2] Ibid., pp. 246-247.

This analysis points up a radical difference between contextualism, on the one hand, and formism and mechanism on the other. As Pepper notes, both formism and mechanism assume that an event can be ultimately analyzed into its constituents.

> This assumption is categorially denied by contextualism; for according to its categories there is no final or complete analysis of anything. The reason for this is that what is analyzed is categorially an event, and the analysis of an event consists in the exhibition of its texture, and the exhibition of its texture is the discrimination of its strands, and the full discrimination of its strands is the exhibition of other textures in the context of the one being analyzed--textures from which the strands of the texture being analyzed gain part of their quality. In the extended analysis of any event we presently find ourselves in the context of that event, and so on from event to event as long as we wish to go, which would be forever or until we got tired.[1]

Furthermore, according to Pepper, "there are many equally revealing ways of analyzing an event, depending simply on what strands you follow from the event into its context."[2] The consequences are that in contextualism there is no system of analysis that assures a path to reality, nor is there any level of analysis that reveals a deeper reality.

> There is no cosmological mode of analysis that guarantees the whole truth or an arrival at the ultimate nature of things. On the other hand, one does not need to hunt for a distant cosmological truth, since every present event gives it as fully as it can be given. All one has to do to get at the sort of thing the world is, is to realize, intuit, get the quality of whatever happens to be going on. The quality of blowing your nose is just as cosmic and ultimate as Newton's writing down his gravitational formula. The fact that his formula is much more useful to many more people doesn't make it any more real.[3]

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[1] *Ibid.*, p. 249. [2] *Ibid.*, p. 250. [3] *Ibid.*, p. 251.

The last subcategory of texture is references of strands. Pepper identifies four references (linear, convergent, blocked, instrumental) that can be analyzed according to _initiation_, _direction_, and _satisfaction_.

> A linear reference has a point of _initiation_, a transitive _direction_, and achieves an ending or _satisfaction_. Every word in our sentence is a bundle of such references. We have already followed out some of these in the words "end" and "the." For instance, one of these linear references initiated by "end" (in "at the end of this sentence") reached forward and achieved satisfaction in "sentence." It was the reference answering to the implied question, "End of what?" With the completion of "sentence," we knew "of what" and the reference was satisfied, and that strand terminated. And note the transitive direction with the implied doubleheadedness or before-and-afterness of the reference. From "end" this reference pointed forward to a satisfaction, from "sentence" backward to an initiation, but at any intervening stage such as the writing of the word "this" it pointed both ways.[1]

According to Pepper a _convergent_ reference is one "in which there are either several initiations converging upon one satisfaction or several satisfactions derived from one initiation."[2]

> Return to our sentence. The letter "e" was there repeated seven times. We probably had not noticed it. . . . If now we notice it, we shall see that these seven letters stand out and gather together. They may do so in two ways. If we are looking for them, we have an initiated reference from which we derive seven satisfactions. But if they spontaneously impress us with their identity, then we have seven initiations converging upon one satisfaction.[3]

And it is through the subcategory of convergent references that contextualism interprets the phenomenon of similarity.

> No two things in the world are . . . inherently similar, but only become so when they initiate convergent references. Such references may, indeed, be predicted, but the objects are literally similar only when the strands converge. Before the convergence, they can only be said to be potentially similar. Two five-pound

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[1] _Ibid_., pp. 252-253. [2] _Ibid_., p. 254. [3] _Ibid_.

> lead weights are not inherently similar, but when they react upon scales to produce the identical reading they are similar. And, of course, a five-pound bag of feathers is exactly similar to the weights under these conditions. But what makes all of these similar is their convergence of action on a single effect.[1]

Blocking refers to a situation in which references are initiated but fail to reach satisfaction.

> Smooth-running strands [from initiation to satisfaction] constitute the contextualistic interpretation of what we generally mean by order. Blocking is accordingly a fact of disorder, and it inevitably involves some degree of novelty.[2]

Pepper describes three kinds of novelty which elucidate the concept of blocking.

> When one strand cuts across another, it simply means that an action has been unexpectedly held up by a conflicting action. When the instrusive strand or action has its own past history, we call this sort of novelty an intrusive novelty. . . .
>
> It is possible that all textural novelties are intrusive novelties and are, accordingly, explicable as strands entering a texture from some distant context. But such explanation in contextualism is never to be assumed, but only to be discovered. It is always possible that a strand should be initiated or blocked absolutely and without explanation. Such occurrences we may call "emergent novelties."[3]

"Naive novelties" occur when a strand disappears or appears without any trace to the past or the future. The essential difference between this kind of blocking and "emergent novelty" is that in the latter one can trace the strands into future contexts. The idea of a "naive novelty" is so radical that it is quite unlikely that such novelties would even be noticed.

> A naive ending by definition signifies that a strand has ceased to have any causal connection even the most indirect with any actual present, and consequently any future, events. An utterly meaningless name might be evidence for such an ending, provided

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[1] Ibid., pp. 254-255. [2] Ibid., p. 255. [3] Ibid., p. 256.

> we had reason to think that the name once had meaning and that what it meant has left no other trace in nature. Conversely with respect to the evidence for a naive novelty, we must find evidence for the likelihood that no previous event ever referred to this strand, that its initiation was absolute and not an integration and fusion of other strands.
>
> As we said, there is a powerful practical and intellectual bias against noticing such strands, should they emerge in our textures, and even against admitting their possibility; but there is nothing in the nature of things (that is, in the contextualistic categories) to exclude their existence.[1]

The last type of reference Pepper discusses is instrumental.

> An instrumental action is one undertaken as a means to a desired end and as a result of some obstacle that intervenes between the beginning of the action and its end or satisfaction. Instrumental action accordingly implies a linear reference that has been blocked, and a secondary action which removes or circumvents the blocking. The instrument proper is the secondary action that neutralizes the blocking. And the references involved in this secondary action are the instrumental references.
>
> . . . .
>
> An instrumental reference, therefore, involves three factors: (1) First, it is a linear reference in its own right, with its own initiation and satisfaction. But (2) this satisfaction is dependent upon the satisfaction of the original references which it serves, this dependency or service being the instrumental factor proper, the reference which connects the instrumental strand with the terminal strand. And (3) it is a reference to the blocking strand. An instrumental action is thus a texture in its own right with its own satisfaction, but it is guided on the one side by the supervening terminal action which it serves and on the other by the blocking action which it neutralizes.[2]

The analysis of instrumental references leads Pepper to a broader discussion involving "individual textures" and the quality of events whose spread transcends the immediate.

> One of the strong arguing points for contextualism is that all its categories are derived from the immediacy of any given present event, and that the public world about us is directly derived from these and does not need to be inferred or assumed in the manner of mechanism. The contextualist insists that a study of any private event carries of itself into a public world.

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[1] Ibid., p. 259. [2] Ibid., pp. 260-261.

> The context of a private texture is already some other texture, and the two textures are thus mutually conjoined and interpenetrating, and so as far as we wish, out into any epoch.
>
> This interpenetration of textures in any act of social cooperation is clear enough from the contextualistic categories. But the same is true in any act of ordinary perception. When I perceive a table, there is, according to the contextualist, an interlocking or two or more continuous textures. There is a good deal of evidence for an individual textural continuity which we call the physical table in constant causal interaction with its environment. We would hardly assume that a table which burst upon our vision was a naive novelty.[1]

And when an entity such as a table is not being perceived, "our knowledge of it apart from perception is entirely relational."[2] In the case of relational knowledge of textures we cannot intuit, Pepper claims that

> it consists in the relations or strands of schemes which satisfy predictions. These schemes, such as maps, diagrams, formulas, functional equations, and symbolic systems, are themselves continuants and are instruments of prediction. These have been developed on the basis of past social experience, and their status is a good deal like that of a social institution. Just as the American Constitution is an instrument for governing social affairs, both a summary of past social experience and a guide to future experience, so, with certain modifications, with these schemes. They constitute what is called "the science" of a period, and change from period to period. Some pragmatists have exaggerated the significance of this change in schemes and speak as though the structure of physical nature changed from age to age because "the science" of an age changes. Physical nature may well change in different epochs, but there is no reason in contextualism to identify the structure of nature at a period with "the science" of that period, any more than we must identify the evolution of tree forms with the evolution of saws and axes.[3]

Operational theory of truth

Pepper contends that the method for determining truth known as operationalism is associated with the contextualist world hypothesis.

> The question of truth arises when a strand is blocked. This strand then seeks satisfaction in the context of the blocking

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[1] *Ibid.*, p. 265. [2] *Ibid.*, p. 266. [3] *Ibid.*, p. 267.

> In colloquial terms, a problem arises and we seek a solution of the problem. We proceed then to analyze the situation in search of a hypothesis which will lead us to a solution of the problem. This analysis consists in following out the strands of the blocking conditions in the context of the blocked strand. If the problem is of any complexity, this analysis leads us into various relational schemes. The relations (i.e., the strands) of these schemes are studied in their relation to the blocked strand. A tentative hypothesis is constructed, this hypothesis being in the nature of an instrumental texture with definite references for action. These references are followed out, and this activity is the act of verifying the hypothesis. If the hypothesis is blocked, and accordingly the original blocked strand (the problem) is not satisfied, then the operation is said to be false and the whole process of analysis, construction of hypothesis, and verification starts over again. If, however, the following of the hypothesis leads to the satisfaction of the blocked strand and to the solution of the problem, then the operation is said to be true. Truth is thus the result of an instrumental texture which removes a blocking and integrates a terminal texture.[1]

With this statement as an overview, Pepper then discusses three distinct treatments of the operational theory of truth: the successful working theory, the verified hypothesis theory, and the qualitative confirmation theory. In the successful working theory,

> truth is utility or successful functioning, and that is the end of it. When a rat in a maze tries a number of blind alleys, and is unsuccessful in reaching its goal, its actions are errors, but when it is successful in reaching its goal, it finds the true path. The successful action is the true one, the unsuccessful actions are false. . . .[2]

Pepper quotes James in linking the successful working theory to what is socially approved.

> "The true," he said, "is only the expedient in the way of our thinking. . . . We have to live today by what truth we can get today, and be ready tomorrow to call it falsehood. Ptolemaic astronomy, euclidian space, aristotelian logic, scholastic metaphysics, were expedient for centuries, but human experience boiled over those limits, and we now call these things only relatively true, or true within those borders of experience."

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[1] Ibid., pp. 268-269. [2] Ibid., p. 270.

> James spoke somewhat vaguely, but some of his followers took the equation of truth as "the expedient in the way of our thinking" quite literally. So Ptolemaic astronomy was true while it worked, while it was socially approved, and while it satisfied people to believe in it.[1]

In the verified hypothesis theory of operational truth, the emphasis is on the hypothesis (according to Pepper, this is the orthodox view of contextualistic truth).

> According to this formulation, it is not the successful act that is true, but the hypothesis that leads to the successful act. When there is no hypothesis there is neither truth nor falsity, but just successful or unsuccessful activity. . . .
>
> In the total act of verification there are at least three articulations: the formulation of a symbolic texture (the hypothesis, which may be telescoped into a mere attitude, but which, when fully expanded, appears as a verbal statement), a following out of the symbolic references (the operations), and a satisfaction or blocking of these references (the verification proper). The "successful working" theory attributes truth to the last articulation and renders the previous articulations otiose or nearly so. The "verified hypothesis" theory attributes truth to the first articulation if satisfaction is achieved in the last.[2]

According to Pepper, this view of truth does not give insight into the qualities of nature.

> It insists that a symbolic statement or map or a model is no more than a tool for the control of nature. It does not mirror nature in the way supposed by the correspondence theory, nor is it a genuine partial integration of nature in the way supposed by the coherence theory of organicism. Therefore, says the exponent of the "verified hypothesis" theory, one gets no insight or intuition of the quality of nature out of an operational hypothesis. The texture of the hypothesis is one thing, the successful act which verifies it is another, and the references between simply link the two operationally together.[3]

Operationally, the qualitative confirmation theory is not different from the verified hypothesis theory. The substantive difference lies in the attitude toward the possibility of having insight into the structure of the world. In the qualitative confirmation theory there is a claim to such insight.

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[1] Ibid., p. 271. Pepper is quoting from William James, Pragmatism (New York: Longmans, Green, 1922), pp. 222-223.

[2] Ibid., pp. 272-273. [3] Ibid., p. 275.

> This theory simply stresses the basic contextualistic principles that the meaning of a symbol is found in the quality it leads to and that the quality of a strand takes up the qualities of its context. . . . The referential structure of a true hypothesis therefore does carry through a set of operations and enter into the structure of the event referred to by the hypothesis as its successful verification. . . . A true hypothesis, accordingly, does in its texture and quality give some insight into the texture and quality of the event it refers to for verification.[1]

The characteristics of contextualism are summarized in Table 5. After examining it, the reader will find it helpful to turn to the fifth portion of the preliminary analysis (pages A29-A40) in Appendix II) for an example of written material which projects contextualism.

Organicism

The root metaphor of organicism, according to Pepper, is best expressed by the two common terms organic and integration.

> The organicist believes that every actual event in the world is a more or less concealed organic process. He believes, therefore, that a careful scrutiny of any actual process in the world would exhibit its organic structure, though some of the processes with which we are generally familiar reveal the structure more clearly and openly than others. The categories of organicism consist, on the one hand, in noting the steps involved in the organic process, and, on the other hand, in noting the principal features in the organic structure ultimately achieved or realized. The structure achieved or realized is always the ideal aimed at by the progressive steps of the process.[2]

The categories of organicism are of two kinds ("progressive" and "ideal") and the distinction is important for understanding this world hypothesis.

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[1] Ibid., pp. 275-277. [2] Ibid., p. 281.

TABLE 5

CHARACTERISTICS OF CONTEXTUALISM AS A WORLD HYPOTHESIS*

Categories and identifying features:	Comments:
A. Root Metaphor: HISTORIC EVENT	The historic event is the active, present event and its context and is characterized by verbs (seeing, doing, being, teaching, etc.). Contextual categories are derived from the intuited quality of the historic event. Reality is not inferred.
B. Basic categories: CHANGE, NOVELTY	Contextualism denies absolute structures or inherent order in the universe. Change and novelty are basic to this hypothesis.
C. Categories of this epoch	Quality and texture are categories that account for order in the present epoch.
QUALITY	Quality is the intuited wholeness or total character of an event.
Spread	Every present event has connections with the past and future. A present event has spread and is not a point on a dimensional time scale.
Change	Qualities of events change according to perspectives from which they are viewed.
Fusion	Textures coalesce to form a quality. Individual textures are difficult to discern in highly fused events.
TEXTURE	Texture refers to the elements that make up qualities. Textures also exhibit qualities and are made of strands lying in a context. No analysis of an event leads to absolute reality. The results of analysis depend on context.
Strand	A strand is whatever contributes directly to the quality of a texture. Strands can be seen in terms of purposes or goals.
Context	Context is whatever contributes indirectly to the quality of a texture.
Reference	This subcategory is discussed in terms of initiation, direction, and satisfaction of a strand. If strands are taken as purposive behavior, observation of an action will note the initiation of the action, the goal of the action, and the satisfaction of the goal. Linear references consist of a single initiation and proceed directly to a satisfaction. Convergent references consist of several initiations converging upon one satisfaction, or one initiation culminating in several satisfactions. Blocked references are those in which no satisfaction of a strand is reached. Instrumental references involve actions which are intended to relieve a blocked reference and which permit a strand to reach satisfaction.
D. Schemes (formulas, diagrams, etc.)	These are instruments which do not reveal reality but are considered useful for prediction, explanation, and control.
E. Operational theory of truth	Truth is in the context of human action.
Successful working	Truth is successful action. Those actions which are successful, in terms of their goals, are true. Truth does not give insight into the textures and qualities of nature.
Verified hypothesis	Truth lies in the hypothesis that leads to a successful act. Truth does not give insight into the textures and qualities of nature.
Qualitative confirmation	Truth lies in the hypothesis that leads to a successful act. Truth does give some insight into the textures and qualities of nature.

*Adapted from Stephen C. Pepper's *World Hypotheses* (Berkeley: University of California Press, 1942).

> This opposition between what may be called the progressive categories and the ideal categories is an ineradicable characteristic of organicism, and seems to be the one source of all its difficulties. Ideally, the ideal categories should be the only categories of organicism--and the ardent exponent of this theory with a profound faith in it believes they are,--but without the progressive categories the theory seems rather obviously to lack scope. Yet if the ideal categories are omitted, the progressive categories would inevitably suffer revision in the direction of contextualism, for the root metaphor of "organicism" or "integration" would have been abondoned. . . .[1]

Pepper then develops seven categories for the organicist world hypothesis.

> We shall now proceed to name these categories. We shall name seven. They might be more or less, depending on how detailed one wished to be in his exposition of the theory. They are, as we remarked, the features of any organic or integrative process and its achievement. These are: (1) fragments of experience which appear with (2) nexuses or connections or implications, which spontaneously lead as a result of the aggravation of (3) contradictions, gaps, oppositions, or counteractions to resolution in (4) an organic whole, which is found to have been (5) implicit in the fragments, and to (6) transcend the previous contradictions be means of a coherent totality, which (7) economizes, saves, preserves all the original fragments of experience without any loss. The fourth category is the pivotal point of the system and should be included in both the progressive and the ideal sets. It is the goal and final stage of the progressive categories and it is the field for the specification of the ideal categories. So, categories 1 to 4 inclusive constitute the progressive set, and categories 4 to 7 the ideal set.[2]

Before further discussing the organicist categories, it is helpful to note that the phenomena Pepper uses to explicate them come from the history of astronomy. The following summary of Pepper's organicist categories will frequently refer to astronomical explanations from Anaximenes to Newton.

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[1] Ibid., pp. 281-282. [2] Ibid., p. 283.

Fragments

Isolated pieces of data are fragments in Pepper's terminology, so called because they are not integrated into a coherent explanation.

> The materials of integration are always relative to the previous integrations. "Fragments," in other words, are relative to the degree of achievement reached. For Anaximenes the fragments were the bright appearances and the segments of their motions. For Kepler the fragments were systems of circular motions. For Newton the fragments were Kepler's laws. Accordingly, the category, fragments, is a sort of negative category which acquires significance in terms of the degree of integration not achieved. A fragment is whatever is not integrated. The specification of the fragment is always in terms of the integrations in which this fragment ceases to be a fragment. Just what the fragments of motion were which Anaximenes worked upon as data, he himself could not state until he had systematized these data into circular motions, after which he could specify the data he had been working with as segments of the circular movements which integrated the data. So incidentally with all data, according to the organicist. No scientist really knows what are the data he is dealing with until he has the system in which they are integrated.[1]

Pepper then points out a positive feature of fragments.

> Negative as a fragment is, however, in its specification, it has this very positive feature: that it is the thing that is first given. It is not made up; it comes. Those bright appearances in the sky actually appear. They had an impact and an insistence, even though just what they were was not clear. They were the materials of Anaximenes' system. In the progress of integration, each stage necessarily takes as its materials the fragmentary integration of the stage below. In this sense, fragments are always the actual materials of nature. This is a positive contribution of fragments. Moreover, as we shall see from the seventh category, everything that a fragment gives is in some way true of nature. What is not true, however, is the way a fragment gives it, for its way is fragmentary and that, the organicist believes he can show, is not the way of nature.[2]

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[1] Ibid., p. 290. [2] Ibid., p. 291.

Nexuses

Fragments have an inherent internal drive toward successive levels of integration. This internal drive, which ultimately results in a coherent link with other phenomena, is called a nexus.

> According to the organicist, facts are not organized from without; they organize themselves. Scientists and philosophers and the common man when he thinks are but the channels of integration and, like the spouts of a fountain, serve best when they interfere least and let the materials take the form implicit in them. It was not Anaximenes, Aristotle, Ptolemy, Copernicus, Kepler, and Newton who made astronomy. Astronomy made itself through these and other notable men, and their genius consisted in giving access to the facts and clearing away the obstructions of human bias so that the facts could find their own connections. For the connections were really there all the time, working in nature. . . . This inevitability of connections among fragments, this implication of wholeness contained in them, is what the organicist means by nexus.[1]

Contradictions

The third organicist category concerns contradictions that occur when the nexus of a fragment is expressed.

> The progress of integration is not smooth and continuous, but is a buffeting of fragment against fragment, producing conflict and contradiction which is only resolved in an integration. The nexus of a fragment leads it inevitably into conflict and contradiction with other fragments.[2]

Here Pepper points out a difference between early and later organicists. Early organicists held that each fragment is driven to its opposite and contradictory fragment.

> The early organicists, notably Hegel, thought that there was one and only one course of progress from maximum fragmentariness to ultimate integration. . . . Thesis - antithesis - synthesis is the ever-recurring form in each scene of his drama. A fragment restless in its isolation and "abstractness" is driven by its

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[1] *Ibid.*, pp. 291-292. [2] *Ibid.*, p. 292.

> nexus to a fragment which is its exact opposite and contradictory. These opposed fragments are inevitably connected and inevitably hostile. Each needs and implies the other for its completion, and each is destructive of and contradictory to the other. Thesis and antithesis, they cannot get along without each other and they cannot abide each other. The conflict is finally resolved in an integration, a higher synthesis, which recognizes the claim for each fragment, "transcends" them and harmonizes them in a richer more concrete whole. But presently this whole exhibits an "abstractness" of its own and seeks the whole from which it is abstracted. Its nexus drives it to its own peculiar opposite. These two richer fragments again imply and contradict each other, love and hate each other, demand and try to destroy each other, until a new and still higher and still more concrete synthesis is attained.[1]

While later organicists agree that ultimately all contradictions disappear with the realization of the absolute whole, they maintain that the process toward this realization is not determinate.

> There is no single cosmic path to the truth or to the ultimate integration of fragmentary data. There is not one single inevitable opposite for each fragment. The progress of astronomy might have gone along a somewhat different route. There are many paths from error to truth. The thinner, more abstract, more isolated, or the vaguer and more confused the initial facts or fragments of cognition, the greater the variety of ways in which these may seek explanation. As the fragments get richer, the alternatives become fewer. The less we know about anything, the more ways suggest themselves in general for finding out about it. With the observations in Anaximenes' hands, a thousand plausible hypotheses were possible, but with the data in Newton's hands there was probably only one possible synthesis.
>
> . . . .
>
> The later organicists are accordingly much more flexible in their descriptions of the organizing process than the earlier ones. They observe that appearances are posited or given. They note that the implications of these appearances lead to contradictions with other appearances, and that these contradictions are resolved in systems which coherently organize both groups of appearances. Beyond this they do not prescribe the path of knowledge. Nor do they believe they are prescribing anything at all; they are merely pointing out what actually goes on among the facts of the world. Their argument is through and through illustrative. "Look at the facts of astronomy," they say. "Isn't that the way they went?"[2]

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[1] Ibid., p. 293. [2] Ibid., pp. 294-296.

Pepper then describes the nature of organicist contradiction. While contradiction does ultimately depend on analytic distinctions, it always arises out of empirical phenomena.

> What, then, are these contradictions which with nexuses drive on the facts to their fulfillments? Obviously, organicists do not use the terms as equivalent to contradictions in the formal sense of "not both p and not p." Quite true; though this formal expression of contradiction would be accepted by them as the most abstract, and therefore fragmentary, expression of just what they do mean by contradiction. So far as this expression has significance, they say, and is not a succession of mere marks, it signifies some conflict in fact--such as Anaximenes' observation, let us say, that the appearances called the sun both do and do not imply the existence of one object. The sun's similarity from day to day, and the continuity of the appearances from east to west during the day, signify one object. But if the sun were one object and disappeared in the west, then it should rise in the west like a man who disappears into a cave and comes out again. But the sun always rises in the east, so there must be a new sun every day. Yet the sun cannot both be and not be one object. The conflict among these appearances is resolved by observing the structure of the earth and realizing that the sun could go around behind the mountains to the north and come out on the other side in the east. A contradiction, they point out, is always based on a factual conflict. There are, accordingly, as many kinds of contradiction as there are ways in which fragmentary appearances are unresolved.[1]

One of the telling features of an organicist view of contradiction is a particular attitude toward indeterminateness.

> That [indeterminateness] was the chief trouble with the Ptolemaic system. The compounding of circles for the orbits of planets was not a determinate implication of the observed positions of the planets. It has been pointed out that the Ptolemaic system has never been disproved. The fact is, says the organicist, it never was proved. The observations of the planets never definitely implied those superimposed circles, any more than they implied spirits to push the planets around. What they do imply, says the organicist, is some determinate system, and this implication is contradicted by the indeterminateness of the Ptolemaic system. Precise and determinate predictions which become verified are for

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[1] *Ibid.*, pp. 296-297.

> the organicist the best evidence of the truth of the organization of the data that produced the predictions.[1]

Organic whole

The contradiction of fragments and their nexuses is resolved through successive levels of integration. At each higher level of integration a more well-defined organic whole emerges, and the ultimate would be an "absolute" organic whole. Pepper claims that the progress of each level of integration exhibits three identifying features. First, the system becomes more inclusive as one moves to a higher level of integration.

> The mere bulk of observations increased steadily from level to level of organization in the development of astronomy. One of the remarkable merits of Newton's work was the tremendous added bulk of data brought together by the integration of astronomy and mechanics.[2]

Second, there is an increase in the determinateness of the system.

> In a way, greater determinateness is but a phase of greater inclusiveness. Increase in the precision of observations generally means also increase in the number of facts observed. The telescope did not simply make observations more precise; it also multiplied their number. Determinateness requires that an organization shall not simply fence in all the relevant facts, but that it shall also penetrate into their details and follow their minutest ramifications.[3]

Third, the fact that each higher level is better integrated than the previous level is entailed in the notion of "higher" levels of integration. According to Pepper "the trend of this integration [within astronomy] was in the direction of greater organicity."[4]

> The principle of organicity can be stated in two ways which are not exactly equivalent but which converge in the end upon the same

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[1] *Ibid.*, p. 297. [2] *Ibid.*, p. 299. [3] *Ibid.* [4] *Ibid.*

> fact. According to the first statement, an organic whole is such a system that every element within it implies every other. According to the second, it is such a system that an alteration or removal of any element would alter every other element or even destroy the whole system.
>
> On the basis of either of these statements, we may note degrees of organicity or degrees of approach to complete organicity. Some parts of a system may be highly implicative and others less so. An alteration of an element of a system may have serious effects on some parts of the system and negligible effects on others. But so long as a system does hold together with some degree of implicativeness in its elements, or so long as parts of the system are seen to have some effects on other parts, it is in that degree organic.[1]

After successively higher levels of integration are attained, an absolute organic whole is reached, theoretically.

> At the limit, implication and causality would coalesce, for logical necessity would become identified with ultimate fact. This limit of cognition which is absolute fact is often called for short by the organicists, the absolute.[2]

With respect to the organicist conception of the absolute organic whole, Pepper points out that ultimate integration will never be attained within finite human experience. However, if such a goal were to be attained, the seemingly fragmentary aspect of nature (and all contradictions) would disappear.[3]

Implicitness

Pepper next discusses organicist evidence for the conclusion that "fragments are implicit in the whole in which they are integrated."[4]

> First, the prospective nexus in the fragment [is] directing us by means of the contradictions it encounters to the place where in fact the fragment belongs in the whole; and second [there is] the retrospective acknowledgment when the whole is attained that this is just where the fragment was, in fact, all the time. The

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[1] *Ibid.*, p. 300. [2] *Ibid.*, p. 301. [3] *Ibid.*, p. 302.

[4] *Ibid.*, p. 304.

> earth was really in the gravitational field of the sun all the time. When Newton exhibited the gravitational relations, these relations, we see, were all the time implicit in the observations from Anaximenes to Kepler. Those observations never had any other real place. The previous astronomers simply failed to see where they belonged. The observations were never intrinsically contradictory, and the proof of it is that they all found their coherent places in the Newtonian system.[1]

Transcendence

Transcendence refers simply to the organicist observation that when a higher level of integration is reached and fragments are seen to be implicit in the organic whole, the contradictions brought about by those fragments will disappear. That is, in the absolute there are no contradictions.

> There are no contradictions of details in an organic whole that has taken up its details. We actually see this in the relative integrations which we achieve. We have seen how these more and more nearly approach pure fact. We have seen that complete integration or the absolute is absolutely pure fact. In absolute fact, then, there are no contradictions, for these are in absolute fact completely transcended.[2]

Economy

The final category of the organicist hypothesis refers to the organicist contention that, although all contradictions vanish in the absolute, all phenomena are saved or economized. However, if all contradictions are ultimately transcended, one can ask: What about the feeling of contradiction? Pepper cites the case in the history of astronomy.

> To be sure, certain irrelevancies were excluded, such as Anaximenes' leaves and disks and mountains, Aristotle's crystalline

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[1] Ibid., pp. 304-305. [2] Ibid., p. 305.

> material, Ptolemy's epicycles and eccentrics. These irrelevancies would contradict Newton's system. But what, in fact, were these? For, as Newton's system shows, they were not actually implied by the astronomical observations. They are what we familiarly call "psychological interpretations." A psychological interpretation is, of course, also a fact. But the proper place for a psychological interpretation is not in an astronomical system. In a psychological system, however, it is very relevant. That is where most of the facts belong which were dropped out in the progress of astronomy. Psychology also has its history of successive integrations pointing, just as astronomy does, to the ultimate integration of the absolute. The system of psychology has not however, as yet attained to an integration with the astronomical system. But how whole systems become integrated into a more inclusive system, we have already seen through an excellent illustration of the integration of physics and astronomy. So we can predict that intrinsically the psychological system is integrated with the physico-astronomical system. Just how, we cannot say at the present stage of integration of psychological data.[1]

Coherence theory of truth

Pepper asserts that the coherence theory of truth is associated with an organicist world hypothesis, and he outlines three characteristics of the organicist attitude toward truth.

> (1) Truth is not primarily a relation between symbols and fact or between one fact (such as an image) and another fact. It is not primarily a matter of relation in that sense at all. It is primarily a matter of the amount of fact attained. (2) It follows that there are degrees of truth depending upon the amount of fact attained. (3) It follows that the totality of fact, or the absolute, is true, and is the limit of truth, and the ultimate standard of truth.[2]

According to the first point, Pepper contends that an organicist is primarily concerned with judgments.

> A judgment is precisely a fragment and its nexus. And the truth of a judgment consists precisely in the fragment's finding, through its nexus, a whole in which it is free from contradictions.[3]

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[1] Ibid., pp. 306-307. [2] Ibid., p. 311. [3] Ibid., p. 309.

An elaboration of points two and three shows the sense in which there are degrees of organicist truth.

> Each level of integration resolves the contradictions of the levels below and so removes the errors that were most serious there. Each level brings about an improvement of judgment. Each level exhibits more truth through the higher integration of the facts. There is more truth in Ptolemy than in Anaximenes, more in Kepler than in Ptolemy, more in Newton than in Kepler. It appears that the criteria of truth are precisely the categorial features of the organic whole--inclusiveness, determinateness, and organicity--and that the ideal of truth is the absolute itself.[1]

It is appropriate to conclude this review of the coherence theory of truth by noting Pepper's comments about the superficial confusion between coherence and consistency.

> It [coherence theory] is obviously implied by the categories of organicism and obviously presupposes those categories. In other views coherence may be treated as a gauge of truth but not as its essential nature. In fact, in other views than contextualism coherence is ordinarily confused with consistency, which is, as we know, but the formal shadow of coherence. For consistency is mere formal noncontradiction whereas coherence is the positive organic relatedness of material facts. It follows that the argument sometimes brought against organicism to the effect that there are many self-consistent logical systems, so that consistency is not an ultimate criterion of truth, is irrelevant. It is not formal consistency but material coherence that the organicist sets up as truth. On the basis of his categories this seems to be uniquely determined. His categories and his analysis of evidence may be questioned, but once these are accepted the absolute is inevitable and determinate and without alternatives.[2]

Table 6 displays a summary of the characteristics of organicism. Upon examining it, the reader is urged to turn to the final portion of the preliminary analysis (pages A40-A47 in Appendix II) for an example of written material which projects organicism.

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[1] Ibid., p. 310. [2] Ibid., pp. 310-311.

TABLE 6

CHARACTERISTICS OF ORGANICISM AS A WORLD HYPOTHESIS*

Categories and identifying features:	Comments:
A. Root Metaphor: INTEGRATION	Events and processes are seen to be integrated to varying degrees.
B. Categories	
FRAGMENTS	Fragments refer to experience. An isolated datum is a fragment. Experience is no longer fragmented when seen as integrated in a coherent whole.
NEXUSES	Nexuses are connections among fragments and imply larger, more coherent, integrated wholes.
CONTRADICTIONS	Contradictions occur when the nexuses of an experience lead to conflicting experiences. The conflict can be resolved by a higher level of integration.
ORGANIC WHOLE	The absolute organic whole is approached when all experience is found to be successively integrated into larger and more coherent wholes. The Absolute is the ultimate integration and most coherent organic whole. As the Absolute is approached, the system becomes more inclusive, more determinate, and more integrated. There is no change: therefore, time is not real.
IMPLICITNESS	When an organic whole is reached, the fragments that led to its development are seen to be implicit in the whole.
TRANSCENDENCE	The contradictions of fragments are resolved or transcended when an organic whole is reached.
ECONOMY	All experiences are valid (and are economized or saved) when an organic whole is reached.
C. Coherence theory of truth	There are degrees of truth in relation to the amount of fact obtained. More truth is revealed when there is higher integration of facts. The criteria of truth are the categorial features of the organic whole–inclusiveness, determinateness, and organicity. Truth includes formal consistency but is more than that. It is the positive relatedness of material facts to produce a coherent whole. Accurate predictions are considered evidence for the truth of the organization of the data that produced the predictions.

*Adapted from Stephen C. Pepper's *World Hypotheses* (Berkeley: University of California Press, 1942).

Summary

In this chapter the investigator has developed a conceptual framework designed to facilitate analysis of the relationship between selected concerns about science in the school curriculum and certain pressing social issues. This conceptual framework takes the form of a scheme for analyzing science teaching materials in terms of the "world view" projected to students. World view has now been systematized, in the course of developing the scheme, by the use of Stephen C. Pepper's concept world hypothesis. Comparative characteristics of six world hypotheses have been isolated from Pepper's work animism, mysticism, formism, mechanism, contextualism, and organicism.

This conceptual framework, based as it is on a philosophically systematic treatment of six different world hypotheses, has broader scope and usefulness than solely as an instrument for analyzing science teaching materials. To substantiate that claim, we turn now to a detailed discussion of the significance of this study.

CHAPTER III

SIGNIFICANCE OF THE STUDY

Introduction

This study is significant because it provides a framework for examining curriculum concerns in light of social problems which can be seen as outgrowths of the prevailing world view in North American society. The problems have to do with a sense of meaninglessness with which some people view their existence.

In the past several years an increasing number of social critics have turned their attention to such existential problems. Typically, their explanations assume that world views influence individual behavior and social action by providing frameworks within which attitudes develop and flourish. These attitudes determine how people see themselves and others and how they act toward themselves and others. These attitudes also guide the development of institutions and conventions which complexly influence and reflect all aspects of society: morals, life styles, aesthetics, work ethic, pace of life, technologies, and so on. Members of a society are assumed to be affected by world views, then, insofar as world views indirectly guide personal, institutional, and conventional attitudes and actions toward self and others.

A more specific recurrent theme in explanations intended to account for existential problems is that a "mechanistic world view" has been a significant factor in their development. This is certainly plausible. As will be shown below, a "mechanistic world view," as the sole means for coping with experience, is limited.

This study demonstrates the use of a conceptual framework which is promising as a way to understand the relationship between existential problems and world view. One of the difficulties with social criticism dealing with these issues is that the concepts used by various critics are ambiguous. Terms like "mechanistic world view" and "scientific world view" are used with little attempt to delineate their meaning.

Within a particular critic's analysis, of course, the terms acquire internally consistent meaning through context. But a problem arises when an attempt is made to get a "total picture" on the basis of the many available analyses, since key terms are used variously by different writers. And a rigorously developed "total picture" is required if defensible curriculum prescriptions are to be derived from social criticism, however compelling. The significance of using a conceptual framework based on Pepper's work is that a consistent set of philosophical terms can be used to account for the phenomena variously described by social critics. Such a framework offers relief from an overwhelming number of inconsistent, ill-defined conceptual devices.

This study is significant, furthermore, in that it discusses the relationship of world view and social problems with specific reference to curriculum. The analysis of a science textbook to demonstrate the use of Pepper's work indicates concretely the potential usefulness of the conceptual framework developed in Chapter II. Such an analysis is particularly appropriate since, as noted earlier, science is seen as a dominant force in North American society.[1] The use to which Pepper's work has been put in this study suggests a role for curriculum in dealing with existential problems of society, notably in providing an analytic terminology and structure.

Overview of the Chapter

This chapter has three major parts. The first part consists of selected social criticism pertaining to existential problems. Two intellectual movements are identified, both of which signal a move away from a mechanistic world view. On the one hand, the systems movement indicates a trend toward more holistic attitudes about "knowing" while respecting traditional requirements for knowing (e.g., evidence). On the other hand, the religious movement emphasizes intuition, authority, and revelation as acceptable ways to "know." A brief account of these two movements captures the Zeitgeist relevant to the significance of this study.

After presenting each movement two issues are discussed. First, it is shown how the key terms of the movements can be accounted for in Pepper's comprehensive framework. Second, the curriculum implications of the movements are elaborated in light of the concept of teaching outlined in Chapter I.

The second part of this chapter provides an illustrative example of the broader implications of using Pepper's work to confront curriculum concerns by examining a current issue in science teaching: the creation/evolution controversy. A discussion of this controversy in terms of world hypotheses provides a way of seeing the issue less antagonistically by elevating the discussion to an analysis of the conceptual backing for the two positions. Thus the investigator's conceptual framework, as developed in Chapter II, is shown to have pedagogical significance. This, coupled with the concept of teaching outlined in Chapter I, suggests clear implications for curriculum.

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[1] Roszak, Where the Wasteland Ends, p. xxiv.

The third part of this chapter synthesizes the curriculum implications of the preceding two parts, and examines, more generally, the application of Pepper's work to curriculum. It is argued that this should be done with caution, with a critical eye turned to the concepts used to diagnose social problems. It is in this part that the significance of this study becomes most apparent in pointing to the power of Pepper's work for clarifying a number of concepts in relation to each other, and in suggesting fruitful areas of curriculum research using Pepper's work as a conceptual basis.

Social Criticism and World View

This section presents a context for viewing the significance of world hypotheses. First, selected accounts of social criticism are presented to outline the nature of existential problems in North American society. It is then shown that an aspect of these problems is related to world view. This relationship is seen to be more developed in the literature of the systems and religious movements.

Overview of criticism

North America in the past decade has undergone a period of critical reflection in which many aspects of society have been examined: rights and identity of minority groups, role of women, role of education, life styles, consumer ethic, foreign policy, and sexual mores are examples of issues discussed. Some of the critical reflection bears on the direction toward which our society is headed, and thus involves questions about individual and social purpose. Discussions of purpose have revealed deeper problems concerning the existential status of man. Harman, reflecting on the criticism, postulates that

> the values of society are, or may be, in transition. Advancing technology has an impact on values. (Perhaps more fundamentally values have an influence on what technology comes into application.) So also may values alter as a consequence of perceiving that past values are leading us into untenable situations.[1]

Toffler's popular Future Shock depicts a society in transition and also hints at existential problems.

> We are simultaneously experiencing a youth revolution, a sexual revolution, a racial revolution, a colonial revolution, an economic revolution, and the most rapid and deep-going technological revolution in history. We are living through the general crisis of industrialism. In a word, we are in the midst of the super-industrial revolution.[2]

> The assertion that the world has "gone crazy," the graffiti slogan, that "reality is a crutch," the interest in hallucinogenic drugs, the enthusiasm for astrology and the occult, the search for truth in sensation, ecstasy and "peak experience," the swing toward extreme subjectivism, the attacks on science, the snowballing belief that reason has failed man, reflect

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[1] Willis W. Harman, "The Nature of Our Changing Society: Implications for Schools," in Curriculum and the Cultural Revolution ed. by David E. Purpel and Maurice Belanger (Berkeley: McCutchan Publishing Corporation, 1972), p. 21.

[2] Alvin Toffler, Future Shock (Toronto: Bantam Books of Canada, 1970), p. 186.

> the everyday experience of masses of ordinary people who find they can no longer cope rationally with change.[1]

Reich's analysis of the "Corporate State" provides similar criticism.

> The essence of the Corporate State is that it is relentlessly single-minded; it has only one value, the value of technology-organization-efficiency-growth-progress. The State is perfectly rational and logical. It is based upon principle. But life cannot be supported on the basis of any single principle. Yet no other value is allowed to interfere with this one, not amenity, not beauty, not community, not even the supreme value of life itself. Thus the State is essentially mindless; it has only one idea and it rolls along, never stopping to think, consider, balance, or judge. Only such single-valued mindlessness would cut the last redwoods, pollute the most beautiful beaches, invent machines to injure and destroy plant and human life. To have only one value is, in human terms, to be mad. It is to be a machine.[2]

There are grounds for criticizing these analyses. In part the grounds lie in the extent to which the metaphors do or do not account unambiguously for the phenomena. But, regardless of the extent to which these are unambiguous and penetrating analyses, they do suggest social transition.

Some insight into underlying causes is offered by Michael Novak. Novak attempts to trace what he calls the "experience of nothingness" to issues involving a culture's sense of reality.

> When the dominant myths of a culture are being fragmented by contradictions that can no longer be hidden, and when no new myths or rearrangements of myths have fully taken their place, an increasing number of persons become terrifyingly aware of the unstructuredness and naked freedom of human consciousness. For most people, what their culture accepts as reality is

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[1] Ibid., p. 365.

[2] Charles A. Reich, The Greening of America (Toronto: Bantam Books of Canada, 1970), pp. 94-95.

> reality; their culture's sudden loss of confidence, credibility, and unity disorients them. The aim, structure, and value that the culture had put into existence for them have, in Nietzche's metaphor, been pulled out. Many persons in the culture, of course, including many of high intelligence, continue to support the prevailing but already collapsing myths. Leaders make urgent rededication to original values. Yet in the United States, for example, an articulate fraction of the population no longer believes in the American way of life: not in competitiveness, not in America's moral goodness, not in the automatic blessing of progress, not in the veracity of even the highest public officials, not in the people's basic decency or commitment to democracy.[1]
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> The American way of life has brought to the surface of daily life a basic contradiction between science and humanism. The more science and technology advance, the clearer their inner dynamic becomes. They are not directed toward the good of concrete, individual human beings but toward efficiency. The primary goal of scientific knowledge is power; the primary goal of technology is efficiency. Neither power nor efficiency has a necessary relation to the integrity of persons.[2]

Novak, therefore, suggests that an aspect of the problem concerns world view. The suggestion is reflected in the statement "what their culture accepts as reality _is_ reality." Such a statement entails world view because it deals with how a culture (or a society) perceives reality. It seems, then, that there is an aspect of social criticism that potentially finds its most precise articulation in concepts related to world view. This is important to this study because perceptions of reality are implicit in Pepper's concept of world hypotheses.

An examination of literature which, in a more rigorous way, links a philosophical perspective to social problems reveals two intellectual movements, both of which share an anti-mechanistic bias:

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[1] Novak, _The Experience of Nothingness_, pp. 30-31.

[2] _Ibid._, p. 34.

the systems movement and the religious movement. In the following discussion it is shown that each movement can be described in terms of world hypotheses. It is also shown that the two movements have similar implications for science curriculum.

The systems movement

Discussion of the systems movement here is limited to a perspective represented by the work of Ervin Laszlo and Ludwig von Bertalanffy. This movement is characterized by inquiry emphasizing the whole of phenomena--parts figure in inquiry only in relationship to the whole. There is also an attempt to arrive at principles unique to the whole. As Bertalanffy remarks:

> There exist models, principles, and laws that apply to generalized systems or their subclasses, irrespective of their particular kind, the nature of their component elements, and the relations or "forces" between them. It seems legitimate to ask for a theory, not of systems of a more or less special kind, but of universal principles applying to systems in general.
>
> In this way we postulate a new discipline called General System Theory. Its subject matter is the formulation and derivation of those principles which are valid for "systems" in general.[1]

Laszlo provides a brief historical account of the systems movement.

> The beginning of the twentieth century witnessed the breakdown of the mechanistic theory even within physics, the science where it was the most successful. Sets of interacting relationships came to occupy the center of attention, and these were of such staggering complexity--even within a physical entity as elementary as an atom--that the ability of Newtonian mechanics to provide an explanation had to be seriously questioned. Relativity took over in field physics, and the science of quantum theory in microphysics. The progress of investigation

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[1] Ludwig von Bertalanffy, General System Theory (New York: George Braziller, 1968), p. 32.

> in other sciences followed parallel paths. Biology attempted to divest itself of the ad hoc dualism of a "life principle" as it appeared in the vitalism of Driesch, Bergson, and others, and tried to achieve a more testable theory of life. But the laws of physics were insufficient to explain the complex interactions which take place in a living organism, and thus new laws had to be postulated--not laws of "life forces," but laws of integrated wholes, acting as such. . . . New laws were postulated, which did not contradict physical laws but complemented them. They showed what highly complex sets of things, each subject to the basic laws of physics, do when they act together. In view of parallel developments in physics, chemistry, biology, sociology, and economics, contemporary science became, in Warren Weaver's phrase, the "science of organized complexity."[1]

The systems movement and existential problems

One of the distinguishing features of a systems view is the extent to which it represents a move away from mechanistic paradigms which attempt to explain phenomena by reduction to simplest parts. Laszlo calls attention to this and indicates that reductionist thinking may be at the base of existential problems.

> The demand for "seeing things whole" and seeing the world as an interconnected, interdependent field or continuum, is in itself a healthy reaction to the loss of meaning entailed by overcompartmentalized research and piecemeal analysis, bringing in particularized "facts" but failing in relevance to anything of human concern. In the 19th century, the existential vacuum was provoked by the then fashionable attitude of nihilism. Today, as Frankl points out, nihilism is out of fashion but it reappears under the guise of reductionism: the typical mark of specialization. . . . Frankl is mainly concerned with the reduction of human phenomena to unconscious drives and aggressions and these in turn to physiological mechanisms. Yet reductionism is the more widespread phenomenon of tracing observed or inferred processes to their smallest parts and explaining them by the interaction of these. Such practice, while contributing much noteworthy detailed knowledge of isolated events, leaves out of consideration larger

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[1] Ervin Laszlo, The Systems View of the World (New York: George Braziller, 1972), pp. 11-12

> interconnections which may be decisive for the understanding of the phenomena. It brings about specialization with all its attendant features: special languages, methods, constructs, foci of attention, and so on. In short, reductionism generates a multiplicity of limited-range theories, each of which applies to a small domain of highly specific events but says nothing about the rest. . . . In consequence, the accumulation of highly specific bits of knowledge fails to give meaning to wider chunks of experience and does nothing to fill the present existential vacuum. Specialized science is simply irrelevant to the question of meaning in life. But the latter cannot be dismissed with a wave of the hand, as specialists tend to do; there are good indications that there is such a thing as a "will to meaning" in man as one of his most basic motivational forces, and that some 20% of contemporary neuroses are due to its frustration.[1]

The corroborating view of Bertalanffy, with his use of the terms "physicalistic world picture" and "modern world view," forcefully shows that world view is an underlying issue.

> The 180 years or so since Kant's writing have seen the Industrial Revolution and, in the near past, the atomic Revolution, the Revolution of Automation and the Conquest of Space. But there appears to be a break. The breathtaking technological development and the affluent society, realized at least in some parts of the globe, have left us with anxiety and meaninglessness. Physics, with all its stupendous modern insights, is not the crystal-clear structure Kant believed it to be. Kant's moral imperative, even if not eroded, would be much too simple for a complex world. Even apart from the menace of physical annihilation, there is the feeling that our world vision and system of values are breaking down in the advent of Nihilism which Nietzsche prophetically forecast at the turn of our century.
>
> Considered in the light of history, our technology and even our society are based on a physicalistic world picture which found an early synthesis in Kant's work. Physics is still the paragon of science, the basis of our idea of society and our image of man.
>
> In the meanwhile, however, new sciences have arisen--the life, behavioral, and social sciences. They demand their place in a modern world view, and should be able to contribute to a basic reorientation. Less advertised than the contemporary revolutions in technology but equally pregnant of future possibilities is a revolution based on modern developments in biological and behavioral science. For short, it may be called

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[1] Ervin Laszlo, "Systems Philosophy," Main Currents in Modern Thought, XXVIII (November-December, 1971), pp. 56-57.

> the Organismic Revolution. Its core is the notion of system--apparently a pale, abstract and empty concept which nevertheless is full of hidden meaning, ferment and explosive potentialities.[1]

The systems movement and world hypotheses

Before showing curriculum implications of the systems movement, it is important to demonstrate that the movement can be accounted for in terms of Pepper's treatment of world hypotheses.

Three world hypotheses are holistic. First, contextualism incorporates the idea of wholes in two categories: "quality" and "texture." As discussed in Chapter II, textures (e.g., lemon, water, sugar) are fused to form a quality (e.g., "lemonadeness") which is the whole perceived by an individual.

Second, the root metaphor of organicism is integration, which incorporates the idea of wholes even more than does contextualism. In organicism, fragments of experience are found to be integrated into larger, more encompassing "organic wholes." (Note the emphasis on integration in Laszlo's reference to "laws of integrated wholes," as quoted above on page 91.)

However, the world hypothesis most similar to the systems view is Pepper's selectivism (treated in his Concept and Quality, but not in World Hypotheses, as discussed in Chapter II). In reviewing Laszlo's Introduction to Systems Philosophy,[2] Pepper states that

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[1] Bertalanffy, pp. 186-187.

[2] Ervin Laszlo, Introduction to Systems Philosophy (New York: Gordon & Breach, 1972).

> a natural system is never a completely isolated whole. It is always involved in an inner and outer environment. This is a characteristic of nature which system analysis brings out in a manner never so empirically stressed before. Adaptation is a transaction in which everything in the natural world is involved. Moreover, the natural world in Laszlo's world hypotheses comprises everything that is. This is what empirically turns out to be the case as becomes clearer and clearer as we proceed with his philosophy. And this is not a consequence solely of his systems theoretical analysis, his paradigm, and root metaphor. It is rather the reverse, that the empirical material from the sciences and elsewhere just shapes up that way. It just may be that an adequate world hypothesis can be developed through the guidance of this paradigm of a dynamic adaptive system (or selective system as it has also been called).[1]

Later, in a footnote, Pepper observes that Laszlo's systems view parallels his own selectivist world hypothesis.[2]

Thus we see that Pepper's treatment of world hypotheses can indeed be used to account for the systems movement. It represents a move away from a mechanistic world hypothesis toward organicist, contextualist, and (particularly) selectivist world hypotheses.[3]

Curriculum implications of the systems movement

A basic tenet of the systems movement is that mechanism is a limited world view and that a systems view is more adequate in accounting for complex phenomena, such as living organisms. The extent to which curriculum materials project an inadequate world view is a question resulting from the preceding discussion of the systems movement. Do science curriculum materials, for example, generally reflect a move away from mechanism and toward more holistic world hypotheses? That in some cases they might not is seen in Ausubel's interesting analysis of high school biology materials produced by the Biological Sciences Curriculum Study (BSCS) in the United States. In commenting on the BSCS texts, Ausubel argues that

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[1] Stephen C. Pepper, "Discussion: Systems Philosophy as a World Hypothesis," Philosophy and Phenomenological Research, (June, 1972), p. 549.

[2] Ibid., p. 551.

[3] For reasons noted in Chapter II, selectivism is not included in the conceptual framework developed in this study.

> the mechanistic bias in the . . . [Yellow and Blue] versions is excessively and unabashedly polemical. Such topics as the biochemistry and synthesis of organic compounds and digestion *in vitro* are unwarrantedly discussed in the context of discrediting vitalism. It is strongly implied that differences between lower and higher levels of organization (e.g., molecular, cellular, organ and tissue, the individual, populations, etc.) are differences in degree rather than in kind, and that phenomena at the higher levels will *ultimately* be explainable by laws that apply at the molecular level. Although it is legitimate to express this type of reductionistic bias in the philosophy of science, it should at least be stated as a bias; and *current* alternative positions should also be fairly presented. The classical vitalistic position is no longer seriously advanced today, and hence constitutes a "straw man" alternative.[1]

Ausubel's comments pertain to biological science in the curriculum. Implications for curriculum materials in the physical sciences turn on the extent to which provision is made for students to see that mechanism is appropriate to account for some phenomena. Yet it is not necessarily appropriate to account for *all* phenomena, or even for all phenomena studied in the physical sciences.

Given the concept of teaching outlined in Chapter I, a more fundamental curriculum implication is the acknowledgment of alternative world hypotheses. It has been argued, in Chapter I, that provision for intellectual independence requires that students be made aware of intellectual foundations of knowledge claims. If intellectual independence is valued as an educational goal, then provision must be made for students to be aware (1) that knowledge claims are products of world hypotheses, and (2) that world hypotheses determine the nature of knowledge claims by providing an orientation for interpreting phenomena.

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[1] David P. Ausubel, "An Evaluation of the BSCS Approach to High School Biology," *The American Biology Teacher*, XXVII (March, 1966), p. 183.

Making provision for students to be aware that knowledge claims can originate from different world hypotheses requires, clearly, that they be made aware that there are alternative world hypotheses. (Ausubel's comments certainly suggest this.) It is also necessary to show that world hypotheses have strengths and weaknesses as ways of interpreting phenomena. This provision is necessary if students are to see that some world hypotheses might be more adequate than others for coping with human existence and experience.

The issue for science in the school curriculum is not, "Which world hypothesis is best?". Rather it is, "What are world hypotheses, and what are their implications as ways of coping with experience?". Making provision for students to be aware of these implications by explicitly providing a basis for understanding the issues is a necessary step toward enabling students to make an informed choice about how they wish to interpret phenomena. For example, awareness of the limitations of mechanism is a prerequisite for understanding the consequences of personal and social action based on such a world view. If the arguments of the systems movement are sound, providing for such awareness would be attacking the roots of the experience of nothingness.

The religious movement

If providing for student awareness of alternative world hypotheses is taken seriously, the discussion must be seen in a broader context than world hypotheses implied in the systems movement as alternatives to mechanism. A broader context is found by examining literature representing what is here called the religious movement. The religious movement is distinct from the systems movement, although they both share an anti-mechanistic bias. Later in this chapter a basis for the distinction is made with the aid of Pepper's work.

If world views are reflected in what a culture considers to be grounds for knowing and explaining, then appeals to different ways of knowing and explaining may indicate shifts in world views. It has become apparent in the past several years, for example, that there is an appeal for ways of knowing and explaining which lie outside the bounds of science. Toffler, as noted above, refers to

> the enthusiasm for astrology and the occult, the search for truth in sensation, ecstasy, and 'peak experience,' the swing toward extreme subjectivism, the attacks on science, the snowballing belief that reason has failed man, . . . "[1]

In a similar vein, Needleman notes that

> bookstores are crammed with Eastern sacred texts, studies of astrology, reincarnation, states of consciousness, and the like. Students across the country are demanding courses in Buddhism, Hinduism, and mysticism. . . . Psychiatrists, psychologists, and clergymen of all faiths are joining the younger generation in this pursuit. . . .[2]

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[1] Toffler, Future Shock, p. 365.

[2] Laszlo, "Systems Philosophy," p. 56. Laszlo is quoting from Jacob Needleman, The New Religions (Garden City, New York: Doubleday & Company, Inc., 1970), pp. xi-xii.

These phenomena are indicative of an underlying shift in world view which has religious overtones. Roszak, in the preface to Where the Wasteland Ends, notes the religious nature of the movement.

> There is a strange, new radicalism abroad which refuses to respect the conventions of secular thought and value, which insists on making the visionary powers a central point of political reference. This book is written against a background of significant, if as yet amorphous religious renewal in the western world. . . .
>
> The religious renewal we see happening about us--especially among disaffiliated young people, but by no means only among them--seems to be neither trivial nor irresponsible, neither uncivil nor indecent. On the contrary, I accept it as a profoundly serious sign of the times, a necessary phase of our cultural evolution, and--potentially--a life-enhancing influence of incalculable value.[1]

The religion to which Roszak refers is not that of the established church but is closer to a world view.

> I mean religion in its perennial sense. The Old Gnosis. Vision born of transcendent knowledge. Mysticism, if you will--though that has become too flabby and unrefined a word to help us discriminate among those rhapsodic powers of the mind from which so many traditions of worship and philosophical reflection flow.[2]

The religious movement and existential problems

Roszak contends that the limitations of mechanism are in part responsible for existential problems of society. The limitations are manifest in the myth of objective consciousness.

> Once again, it is important to recall Michael Polanyi's contention that a purely impersonal knowledge is impossible to come by even in the exact sciences. But if an epistemology of total objectivity is unattainable, a psychology of objectivity is not. There is a way to feel and behave objectively, even if

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[1] Roszak, Where the Wasteland Ends, pp. xxi-xxii.

[2] Ibid., p. xx.

> one cannot know objectively. Indeed, the capacity of people to depersonalize their conduct--and to do so in good conscience, even with pride--is the distinctive psychic disease of our age. We must return once again to the intimate link between the search for an epistemological objectivity and the psychology of alienation: that is, to idolatrous consciousness. It is no mere coincidence that this devouring sense of alienation from nature and one's fellow man--and from one's own essential self--becomes the endemic anguish of advanced industrial societies. The experience of being a cosmic absurdity, a creature obtruded into the universe without purpose, continuity, or kinship, is the psychic price we pay for scientific "enlightenment" and technological prowess.[1]
>
> When, therefore, our powers of proprioception dim, it is more than a personal misfortune. It is also the foreclosure of our ability to know nature from the inside out. Or, to put it another way, it is the beginning of that scientific objectivity whose extreme has been reached with western society's total conversion to mechanistic reductionism.[2]

The renewed interest in transcendental issues is considered by Roszak to be a source of relief from the existential malaise brought about in part by mechanistic reductionism.

> The repression of the religious sensibilities in our culture over the past few centuries has been as much an adjunct of social and economic necessity as any act of class oppression or physical exploitation; it has been as mandatory for urban-industrial development as the accumulation of capital or the inculcation of factory discipline upon the working millions. . . . The loss of the transcendent energies in our society has been taken by few radical leaders of the past two centuries to be a privation as great as any due to physical hardship or the violation of personal dignity. For the most part, it has not been experienced as a loss at all, but as an historical necessity to which enlightened people adapt without protest, perhaps even welcome as a positive gain in maturity.
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> . . . .
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> This book stems from the conviction that, in the course of our generation, many proud traditions of protest and reform have grown as depleted as the life-resources of that environment may

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[1] Ibid., pp. 167-168. [2] Ibid., p. 98.

> soon be. It is the energy of religious renewal that will generate the next politics, and perhaps the final radicalism of our society. Already it is those who speak from the perspective of that renewal who provide the shrewdest critique of our alienated existence, the brightest insight into the meaning of liberation.[1]

Roberts contends that a fundamental myth of science is that "explanation, prediction and the implied possibilities for control of phenomena constitute a useful, meaningful and sufficient way to cope with experience."[2] The essential message of the religious movement is that science is not a sufficient way to cope with all experience, nor is it the only way to "know." In short, science is not concerned with transcendental questions like those related to the "why" of man's existence. And those questions, according to Roszak, are dealt with most effectively by alternative world views represented in the religious movement.

The religious movement and world hypotheses

The religious movement can be accounted for in terms of Pepper's world hypotheses animism and mysticism. The basis for distinguishing between the religious and systems movements (even though they share an anti-mechanistic bias) is found in a concept of evidence implicit in Pepper's treatment of world hypotheses. In the interests of clarity, the basis for the distinction will now be examined.

A concept of evidence can be used to distinguish animism and mysticism, on the one hand, and formism, mechanism, contextualism, organicism, and selectivism on the other. Three world hypotheses were suggested as alternatives to mechanism in the discussion of the systems movement: contextualism, organicism, and selectivism. All three of these world hypotheses (plus formism and mechanism) have a fundamental similarity in that a concept of evidence is prominent in their epistemologies. Not one of these world hypotheses eschews evidence as a condition for at least some knowledge claims.

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[1] Ibid., pp. xxi-xxiii.

[2] Douglas A. Roberts, "Science as an Explanatory Mode," Main Currents in Modern Thought, XXVI (May-June, 1970), p. 132.

This serves as a basis for distinguishing the systems movement from the religious movement. The epistemologies of the two world hypotheses representing the religious movement, animism and mysticism, do not imply a concept of evidence. In animism

> what a great spirit says is true, and what the greatest spirit says is most true. When the direct word of a spirit cannot be obtained--in his immediate presence, in dreams, in voices, in omens, in prognostications, in sacred traditions, or in holy books--then the word of the most authoritative representative of a spirit must be taken.[1]

Here it is clear that authority, not evidence, is required for knowledge claims. Nor is evidence recognized in a mystical world hypothesis. In mysticism "the revelation of the experience is the truth."[2] A mystical experience is "supremely cognitive and revelatory . . . , immediate and totally uninterpreted . . . , certain and indubitable. . . ."[3] Clearly, there is no room for evidence in mystical claims to knowledge.

Therefore, as is implicit in Pepper's treatment of world hypotheses, the systems and religious movements can be distinguished on the absence or presence of a concept of evidence. In elaborating the distinction, it is clear that Pepper's work is as applicable to understanding the religious movement as the systems movement.

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[1] Pepper, World Hypotheses, pp. 122-123. [2] Ibid., p. 130.

[3] Ibid., p. 128.

Curriculum implications of the religious movement

The curriculum implications of the religious movement are not only similar to, but more radical than, those of the systems movement. The religious movement similarly holds, for instance, that mechanism as the only way of coping with experience is too limited an approach.

The world hypotheses of animism and mysticism, representing the religious movement, are different from those discussed in the systems movement, because evidence is not a condition for "knowing." But, animism and mysticism are world hypotheses and consequently give rise to knowledge claims and explanations. Claims to "know" and to "explain" are quite different from scientific knowing and explaining because of the absence of the evidence condition; but it cannot be denied that the claims originate from world hypotheses.

If intellectual independence is an educational goal, then there is an obligation to provide for students to be aware of animism and mysticism as alternative world hypotheses, since these too give rise to knowledge claims and explanations. One of the implications of this for science teaching is that it elevates the discussion to a comparison of science (as seen in formism, mechanism, contextualism, organicism, and selectivism) with other ways of knowing and explaining (as seen in animism and mysticism)--each to be discussed in its own terms, exhibiting its merits and limitations.[1] Explicitly exposing the categories of world hypotheses, and demonstrating their merits and limitations, are necessary requirements in providing for the student to make an informed choice as to how he wishes to cope with experience.

The power of scientific explanation, and the implied possibilities for control of phenomena, are well known; an individual may indeed wish to use a "scientific way to explain" in many circumstances. Yet, if Roszak's analysis is correct, the world hypotheses of animism and mysticism have potential for dealing with transcendental issues of no mean importance. The question of the worth of animism and mysticism for coping with experience ultimately translates to the question, "Are transcendental issues important?" The religious movement is evidence that such issues are important and that perspectives different from science might handle them in powerful ways. The curriculum implication of this point is that frameworks must be provided for students to be aware of all world hypotheses--what kind of knowledge claims and explanatory statements can come from them, and what their strengths and weaknesses as ways of coping with experience are.

The Creation/Evolution Controversy

It has been argued that one of the implications for science teaching of the religious movement is that science be compared with others ways of knowing and explaining. This part of Chapter III shows a concrete example of the use of world hypotheses for clarifying an issue concerning that very implication--the creation/evolution controversy. In the following discussion, then, world hypotheses are seen to have immediate application in science education.

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[1] Roberts effectively argues a similar point in his "Science as an Explanatory Mode."

Efforts on behalf of special creation

The present educational controversy on this matter in the United States began with efforts to have the biblical account of special creation presented in biology textbooks as an alternative to the theory of evolution. According to Mayer, in some cases (as in the State of California) efforts have been focused on arranging "textbook selection requirements in such a way that books of the Creation Research Society could be given preferential treatment."[1] In other cases, legislation has been introduced requiring that special creation be given equal time with evolution in biology teaching. Mayer quotes a relevant passage from House Concurrent Resolution No. 1011, introduced to the Judiciary Committee of the Colorado State Assembly:

> Section 17. Equal teaching of creation. Any public school, state-supported institution of higher education, or other institution or facility in this state supported in whole or in part with state funds, which teaches, displays, presents, or makes information available to persons in this state on the origins of life, man, and the universe, shall include, teach, display, present, and make equally available, beginning September 1, 1973, with equal time, space and tax money expended to such persons, textbooks, displays, outside speakers, information, and seminars, on BOTH the

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[1] William V. Mayer, "The Nineteenth Century Revisited," BSCS Newsletter, No. 49 (November, 1972), p. 9. (This entire issue is devoted to the creation/evolution controversy.) One book such as Mayer alludes to is John N. Moore and Harold S. Slusher, eds., Biology: A Search for Order in Complexity, prepared by the Textbook Committee of the Creation Research Society (Grand Rapids, Michigan: Zondervan Publishing House, 1970).

> evolution and biblical creation science theories, with equal amounts of creation-oriented textbooks and materials available on all creation-related sciences and character-shaping philosophies, allowing all students and teachers academic freedom of choice as to which of these two theories, creation or evolution, they wish to choose. Violations of this section and the penalties therefore shall be defined by law.[1]

In Canada the controversy has surfaced in Alberta, where a group called the Committee for True Education has conducted a number of rallies to gather support for having special creation taught in schools as well as evolution.[2] However, the controversy has not yet reached the stage of organized legal action which is apparent in the United States. There lawsuits have been used as another form of attack against teaching evolution without giving equal time to special creation.

> As an example of this genre of attack, William F. Willoughby, a religion editor of the Washington Star, recently filed suit in the United States District Court for the District of Columbia against the National Science Foundation and the Regents of the University of Colorado as holders of the copyrights on BSCS materials. He asked the Court to declare that the National Science Foundation is not permitted by law to fund a project whose purpose is to create biology textbooks presenting the Darwinian theory of evolution as the only credible theory of the origin of man.[3]

Arguments against special creation

Arguments against the inclusion of special creation in the science classroom take several forms. The argument most germane to this discussion is that special creation entails a religious belief, is not a scientific theory in any acceptable meaning of the term, and, therefore, cannot reasonably be included in a science textbook on biology. Mayer makes the point emphatically.

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[1] Ibid., p. 11.

[2] "Teaching of Genesis in Schools Gets Support at Alberta Rallies," The Globe and Mail (Toronto), January 25, 1973.

[3] Mayer, "The Nineteenth Century Revisited," p. 12.

> Fundamentalists have attempted to do the impossible--namely, to put forth their theological position as a scientific one. The Bible is no more a scientific treatise than biology textbooks are theological ones. Fundamentalists use the term *theory* in describing creation, but they use the term in a sense entirely different from that used by scientists. (Whenever the term theory is used in a nonscientific sense hereafter, it is italicized to avoid confusing the reader.) What is meant by creation *theory*? What are its hypotheses? What are its data sources? What are the experiments that tend to confirm it? In short, if one is to consider a creation *theory* seriously, it must be subject to the tests demanded of all scientific theories. That no such tests have been made, and that none is available for examination, should be apparent to all. There is no creation *theory*, of course, but rather a religious belief that is quite outside the realm of scientific investigation.[1]

In a similar vein, Lee comments as follows in his outline of the BSCS position on teaching biology.

> Evolution is a scientific theory in the sense that it is based on scientific data accumulated over many years and organized into a unifying idea widely accepted by modern biologists. The BSCS is concerned with any scientific theory relevant to the biological sciences that can be dealt with in terms of scientific data accumulated and organized. It is not, on the other hand, concerned with religious doctrines that are based only on faith or beliefs, nor does it consider them relevant to the teaching of biological science.[2]

Stebbins makes the point also.

> The only alternative to evolution that is seriously proposed to explain the origin of different kinds of animals, plants, and mankind is special creation. Scientists cannot deal with this alternative, since it is not science. Scientists build and test hypotheses; the "creationists" would have us accept special creation on faith, if

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[1] *Ibid.*, p. 8. A similar argument is made by James T. Robinson, "Incommensurability of Evolution and Special Creation," *American Biology Teacher*, XXXIII (December, 1971), pp. 535-538. Robinson was responding specifically to Duane T. Gish, "A Challenge to Neo-Darwinism," *American Biology Teacher*, XXXII (November, 1970), pp. 495-497.

[2] Addison E. Lee, "The BSCS Position on the Teaching of Biology," *BSCS Newsletter*, No. 49 (November, 1972), p. 6.

> they have, to their satisfaction, gathered enough "evidence" to cause them to doubt the occurrence of evolution. The belief in special creation is untestable. Those who advocate its inclusion in the science curricula of our public schools do not permit scientists to criticize or examine it. One cannot question the ability or the way in which a supreme being could have created the millions of different kinds of living organisms that exist on the earth.[1]

The essence of the curriculum argument, then, appears to be the following: science courses teach science; special creation is not science (not a scientific theory); therefore, the inclusion of special creation is not justified in science courses. Provisionally, there is no faulting this argument.

A broader perspective

Yet, notwithstanding the cogent argument that special creation is not a scientific theory, the curriculum argument stated above can be questioned when looked at from a broader perspective. Questions arise when the argument is examined in the context of the current social milieu which allowed the controversy to flourish. In view of the religious movement, for example, the argument is trivial for it ignores a central issue--how people wish to deal with reality. The curriculum argument evades the fact that, as Roberts has pointed out, in most schools "science is the only explanatory mode given systematic treatment in the curriculum, and the emphasis is on having learners adopt and develop patterns of thinking and attitudes which are appropriate to scientific explanation."[2] Thus, if the problem is looked at from the standpoint of "ways to know," rather than from the more narrow "scientific ways to know," it is found that our educational system tends to be somewhat single-minded when it comes to alternative world views. The evolutionist position is protected by this single-mindedness.

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[1] G. Ledyard Stebbins, "Evolution as the Central Theme of Biology," ibid., p. 4.

[2] Roberts, "Science as an Explanatory Mode," p. 137.

World hypotheses and the creation/evolution controversy

A potentially useful way of coming to grips with this controversy is to recast the two opposing positions in terms of Pepper's world hypotheses. To do so makes it clear that the difficulty lies in two competing conceptual perspectives and, therefore, it is not resolvable by argument within either perspective.

The position of the "special creationists" can be understood in terms of the world hypothesis animism, one identifying characteristic of which is a theory of truth based on infallible authority. For special creationists, infallible authority is the Bible.

One basis for distinguishing animism from world hypotheses associated with science (formism, mechanism, contextualism, organicism, or selectivism) is that the latter five rely on a concept of evidence, as discussed earlier, while animism does not. The specification of a single world hypothesis by which to understand the position of the "evolutionists" is not crucial for this discussion. Suffice it to say that none of the world hypotheses associated with science is inconsistent with a theory of evolution.

It is interesting, nevertheless, to consider briefly some aspects of the theory of evolution in terms of the world hypothesis mechanism (since the religious movement in general is anti-mechanistic). Within evolutionary theory, certain observable phenomena are explained by reduction of the evidence to interactions of inferred particles which have a location in time and space. For example, mechanism is implicit in Stebbins's comments on the origin of life.

> A second objection made by the "creationists" to modern evolutionary theory is that biologists cannot explain the origin of life. This statement is also erroneous. Several experiments have shown that the basic molecules of which living organisms consist can be synthesized from compounds that were almost certainly present on the primeval earth. The methods of synthesis imitate processes that could very probably have taken place when a terrestrial environment favorable for life first appeared. The arrangement of these molecules into functional systems that were self-reproducing, and their evolution finally into the first cellular organisms, can be explained by processes of chemical mutation, recombination, and natural selection similar to the processes that have been experimentally demonstrated to be responsible for change of micro-evolutionary order in contemporary organisms. Experiments by biochemists have shown that these processes can operate to produce progressive change in acellular systems similar to the processes that are postulated to have preceded the development of cellular forms of life.[1]

Other aspects of evolutionary theory could be used to show how it is not inconsistent with the other world hypotheses associated with science: formism, contextualism, organicism, selectivism. A concept of evidence would inevitably be involved, though, and in no case would aspects of the theory rely on infallible authority as the basis for truth.

In the example above, the creation/evolution controversy has been characterized as a difference between animism, on the one hand, and mechanism on the other. (As has just been stated, the controversy could also have been characterized as a difference between animism, on the one hand, and any of formism, contextualism, organicism, or selectivism, on the other.) Since opposing arguments in our example ultimately reduce to a difference in two world hypotheses (animism and mechanism), arguments generated by either group can only be at cross-purposes. Stebbins's point in citing evidence for the molecular origin of life literally falls on deaf ears, for someone who explains the origin of man according to an animistic world hypothesis. There is no concept of evidence in animism. Conversely, anyone arguing for the infallible authority of the Bible as the basis for truth in this matter will not be "heard" by a person who explains the origin of man by any of the five world hypotheses associated with science, wherein infallible authority is not accepted as a basis for truth. Mayer recognizes the problem when he says that

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[1] Stebbins, "Evolution as the Central Theme of Biology," p. 4.

> they [science student teachers] were not led to comprehend that the data of science, having been derived by experiment and observation, has a certain validity on the face of it, but that it is not necessarily comparable to data derived through other systems. . . . If there were adequate understandings that both science and theology are discrete ways of knowing, this difficulty would not arise.[1]

Curriculum implications of the creation/evolution controversy

A concept of teaching in which an essential component is to make provision for students to understand the basis for knowledge claims is well tailored to Mayer's remarks, above. Furthermore, as arises out of the discussion of the religious movement, it is not sufficient to continue to ignore alternative world hypotheses in curriculum deliberations--especially about the role of science in the school curriculum. A defensible approach to the creation/evolution controversy would be to provide students with a basis for understanding the differences among alternative world views. Pepper's treatment of world hypotheses is well suited for that purpose.

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[1] Mayer, "The Nineteenth Century Revisited," p. 7.

The Potential of a Conceptual Framework Based on "World Hypotheses"

It has been shown that the conceptual framework developed by the investigator in Chapter II can be used to describe and interpret the systems and religious movements. This means that certain social phenomena can be discussed within a single encompassing framework, based on Pepper's World Hypotheses, which offers a fairly precise terminology for dealing with the issues. The clarity thus provided is significant, especially given the amorphous nature of the concept world view.

Clarification of terminology

One of the assets of Pepper's systematic work is that it provides a basis for critical examination of diagnoses, causes, and prescriptions for existential problems of society. In the literature of the systems and religious movements, for instance, there is ambiguity with regard to concepts such as "sense of reality," "mechanistic world view," "scientific world view," and "world picture." Granted, these concepts are necessary in arguments which diagnose existential problems of a society. Yet, to act--or even deliberate--on the curriculum implications of these arguments is a precarious enterprise unless some clarity can be had with respect to the basic concepts being used.

For example, if a distinction is made between "science" and "mechanism," then to say that mechanism is at the base of existential problems might call for one kind of curriculum prescription; to say that science is at the base might call for quite another indeed. Yet Roszak uses the two terms to convey a similar meaning, as is evident in these two passages (the first already cited, but repeated here for the present purpose).

> When, therefore, our powers of proprioception dim, it is more than a personal misfortune. It is also the foreclosure of our ability to know nature from the inside out. Or, to put it another way, it is the beginning of that scientific objectivity whose extreme has been reached with western society's total conversion to mechanistic reductionism.[1]
>
> The point cannot be too strongly stated. It makes no automatic psychological difference that we exchange one theoretical model for another, or refine our methods of scientific measurement; the quality of our experience is the heart of the matter. And where evaluation and psychic participation are concerned, the scientific world view remains as undimensioned today as in the age of Bacon and Newton.[2]

One wonders if Roszak means by "mechanistic reductionism," in the first passage, the same as Ausubel means when he speaks of the "mechanistic bias" of the BSCS program. Again, one wonders about the relationship of both terms to "scientific world view" which Roszak mentions in the second passage.

The characteristics by which mechanism can be recognized as a world hypothesis are clearly articulated in the conceptual framework developed by this investigator on the basis of Pepper's work. One sees immediately that mechanism is not the only world hypothesis associated with science. Further, the root metaphor, categories, and theory of truth associated with each world hypothesis provide meaning for each, and therefore offer a network of interrelated terms by which to clarify problems potentially having significance for science in the school curriculum.

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[1] Roszak, Where the Wasteland Ends, p. 98.

[2] Ibid., p. 184.

A conceptual foundation for empirical research

Quite aside from the analytical power of a conceptual framework based on Pepper's systematic treatment of world hypotheses, it is clear that a number of significant questions for empirical research emerge from the discussion in this chapter. For instance, one might examine the influence of world hypotheses on people's attitudes and actions. Another investigation might center on how people acquire world hypotheses. Still others might focus more specifically on curriculum problems, such as whether or not (and how) students at various ages are affected by world hypotheses either implicitly or explicitly conveyed in teaching materials. While no attempt is made in this study to investigate the questions just outlined, part of the significance of the study is nevertheless that it provides a conceptual foundation for such research.

Application as a scheme for analyzing science teaching materials

A final point in this section brings into focus the next argumentative step of the study. The conceptual framework developed by the investigator on the basis of Pepper's systematic treatment of world hypotheses is used as a scheme for analyzing science teaching materials (discussed in Chapter V). The potential of the framework is thus demonstrated, in an exploratory way, by examining its power to discriminate among world hypotheses in written material intended for student use.

The significance of this exploratory demonstration can be seen in the following example. Suppose that an analytically sound argument could be made that a mechanistic world view is at the base of existential problems. Then it becomes a legitimate question to ask how a mechanistic world view is acquired (especially in terms of influence of the curriculum), since the answer to that question is a precondition for curriculum prescription. But before such a question can be answered intelligibly, it is necessary to know what kinds of communication have a mechanistic bias (for this example), that is, are potentially understood by learners in terms of mechanism or other world views. This exploratory demonstration serves as a first step toward a methodology for determination of world view bias in science teaching material, and therein lies its significance.

Before turning to the final argumentative step in Chapter V, however, it is helpful to examine research which is related to the conceptual framework developed in this study. By examining six selected studies in light of world hypotheses, it will be seen that the framework of this study is the only one which has a systematic treatment of world view as its central concern. Thus the conceptual framework developed in this study emerges as relatively more adequate for dealing with the broader implications of world view (as discussed in the present chapter), and for dealing with the development of a methodology for determination of world view bias in science teaching material (as discussed in Chapter V).

CHAPTER IV

REVIEW OF RELATED RESEARCH

Introduction

This review of research is guided by the fact that there seem to be no studies in science education dealing centrally with the comprehensive and systematic notion of world view used in this thesis. But, partly because of the richness of the concept world view, there are studies which are peripherally related to it. The investigator has selected six such studies for review on the basis of their substantive and interesting relationship to world hypotheses. The conceptual framework developed in each study is compared to that developed in this study (Chapter II). The framework based on Pepper's World Hypotheses is seen to be relatively more adequate for dealing with the broad implications of world view and the development of a methodology for determining world view bias in teaching material.

Roberts's study is reviewed because his concept explanatory modes is related to world hypotheses and because his argument has unique implications for science education. The review will focus on his argument because of its influence in guiding the development of portions of the reasoning in the proceding chapter of this thesis. In the remaining five studies, the review concentrates on the relationship of the central concepts to world hypotheses. Schwab's forms of guiding principles of scientific enquiry[1] are examined in some depth because of their close relationship to world hypotheses. A prior study by the present investigator concerns the development of a scheme for analyzing science textbooks to determine the provision made for students to understand the context in which claims are "known." Principles of enquiry are used in that study and, consequently, it too is related to world hypotheses and is discussed here. Campbell's study is included because his concept epistemological posture intersects the concept world hypotheses in several ways. Munby's study is reviewed because it has an orientation similar to that of the present study and because the major concepts he uses, Instrumentalism and Realism,[2] are related to world hypotheses. Finally, Russell's application of Toulmin's argument pattern to science lessons is examined as it relates to Pepper's work.

Explanatory Modes

Roberts develops conceptual devices for portraying the potential of science in the curriculum and for providing insight into expressions of disenchantment with science.

> What seems to be needed is a basis on which magic, science and religion can be compared as explanatory modes. I propose this generic term, to distinguish the kind of comparison I have in mind from the comparison of magic, science and religion as cultural institutions. I wish to focus upon the individual-as-explainer, and upon the consequences for him of the adoption of one or another explanatory mode.[3]

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[1] For consistency, Schwab's spelling of the term "enquiry" has been adopted.

[2] Capitalization of the first letter of these terms throughout this chapter, is consistent with Munby's usage.

[3] Roberts, "Science as an Explanatory Mode," p. 134.

It is important to point out that explanatory modes can be seen in terms of world hypotheses. Roberts's distinction between science, on the one hand, and magic and religion on the other, parallels the distinction between formism, mechanism, contextualism, and organicism, on the one hand, and animism and mysticism on the other.[1] Pepper's four "adequate" world hypotheses[2] each present different interpretations of a scientific explanatory mode, while the magical and religious explanatory modes can be understood according to Pepper's treatment of animism and mysticism (there is not a one-to-one correspondence between the two pairs of terms).

The basis Roberts develops for comparing explanatory modes has a three-part structure: an explanatory corpus, a philosophy, and a mythology. The explanatory corpus is, simply, a body of explanatory statements. Roberts gives an example from magic.

> The statement, "Touch of a woodpecker's beak cures toothache," belongs to what I have called "explanatory corpus," that is, it is on the same order as any other explanatory statement ("God is love," "Germs cause disease").[3]

Thus, for example, most statements in science textbooks are in the service of scientific explanation and are part of the explanatory corpus of science.

The philosophy of an explanatory mode "permits one to understand features of an explanatory statement."[4] For example, the nature of scientific explanation is an issue for the philosophy of science, not for scientific explanatory statements themselves. In the magical and religious explanatory modes there is also a philosophy that permits one to understand the nature of magical and religious explanations. (Roberts points out that, while the philosophy of religion is highly developed, the "philosophy" of magic is unsystematic and is found chiefly in anthropological and ethnological works.)

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[1] Selectivism is not mentioned further in this chapter, despite its mention in Chapter III. The reader will recall that selectivism is not part of the conceptual framework developed by the investigator in Chapter II.

[2] The notion of "adequacy" for a world hypothesis has been explored in Appendix II.

[3] Roberts, "Science as an Explanatory Mode," p. 134. [4] Ibid.

It is worthwhile to note that Pepper's treatment of world hypotheses corresponds to a comparison of the philosophies of explanatory modes. Pepper's concern is not with providing explanatory statements within each world hypothesis, but rather with developing a means for understanding the nature of those statements.

The mythology of an explanatory mode has to do with the reasons for using it as a way to cope with experience. The status of such a mythology is revealed in Roberts's examination of the three-part structure of a religious explanatory mode.

> There is, embodied in every religious doctrine, a body of statements whose purpose is to explain phenomena of various sorts. In addition there are highly developed philosophies of religion which permit one to thread one's way around in the explanatory corpus. Yet the reasons for coping with experience through a religious explanatory mode are, like similar assertions for science and magic, different from either the statements of the explanatory corpus or statements from philosophies of religion.[1]

As an example of a statement from the mythology of science, Roberts defines what he calls The Fundamental Myth of Science in the following way.

> Explanation, prediction and the implied possibilities for control of phenomena constitute a useful, meaningful and sufficient way to cope with experience.[2]

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[1] Ibid. [2] Ibid.

Roberts describes the functions of a mythology and argues that science has an inadequate mythology, a state of affairs which stems from the inability of science to reduce anxiety arising from phenomena over which man has no control.

> Explanation and prediction, no matter how highly developed, are simply not adequate as a way to cope with all of human experience. This is not a trivial observation if one considers that, in virtually every school system in the Western world, some study of the scientific explanatory mode is mandatory.[1]

He then suggests how this inadequate mythology relates to disenchantment with science.

> As scientific explanation is accorded increasing value within a culture, . . . one wonders what coping strategies will evolve for dealing with anxiety--unless, of course, the human organism is becoming less prone to anxiety. How interesting, as Roszak pointed out, that we find developing among the young a willingness to "scrap our culture's entrenched prejudice against myth, religion and ritual."[2]

The implications of Roberts's analysis for science education involve three major provisions:

> First, provision would have to be made for learners to become aware that they are explaining (and not reporting on intellectual inspection of reality), when they use statements from the explanatory corpus of science, and that this procedure has demonstrable but limited utility. . . .
>
> Second, provision would have to be made for learners to become aware that there are other explanatory modes, and that these also have demonstrable (but limited) utility as ways to cope with experience. . . .
>
> The final consideration is the most important of the three. Provision would have to be made for learners to become aware that considerations within the mythology of an explanatory mode are at least as important as considerations within its philosophy. While the latter is a complex of rules which govern the form to be taken by imagery (e.g., dictating the nature of allowable postulated

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[1] Ibid., p. 136.

[2] Ibid., p. 137. Here Roberts is quoting from Theodore Roszak, The Making of a Counter Culture (Garden City, New York: Doubleday & Company, 1969), p. 145.

> entities), it is in the former that one finds the purpose behind developing any imagery at all.[1]

The significance of Roberts's analysis is that it provides conceptual devices for stepping outside a scientific explanatory mode and comparing it with other explanatory modes. If the mythology of science is inadequate, the ability to "step outside" science is important since such an inadequacy clearly cannot be administered to from within science. Therein lies a similarity between Pepper's treatment of world hypotheses and Roberts's treatment of explanatory modes. Both present frameworks which are useful for "stepping outside" to examine the features and consequences of their internal concepts. (The analysis of the creation/evolution controversy in Chapter III, for example, could have as well been performed using Roberts's concept of explanatory mode.) This thesis is also similar to Roberts's analysis in that either study is significant because it deals with frameworks allowing comparisons between alternative world views and thus contributes to a solution of social issues of an existential nature.

Forms of Principles of Enquiry

Schwab's forms of principles of enquiry in science are examined because his ideas have been influential in science education. In the following analysis it is shown that, at various points, there is strong similarity between forms of principles of enquiry and world hypotheses. Those points which lack similarity can be explained in terms of Pepper's work.

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[1] *Ibid.*, p. 138.

Overview

Principles of enquiry, according to Schwab, are ideas or conceptions which focus an enquirer's idea of how enquiry should proceed. It is evident that principles of enquiry are also closely related to an enquirer's world view.

> We shall use "principle" to stand for the ideas which initiate and guide any planned activity. "Principle of enquiry" thus stands for the notions which initiate and guide the course of a line of research. . . . A principle of enquiry in this sense may arise from a doctrine consciously known and espoused by the scientist or it may be simply his habit, his unexamined way of recognizing his subject matter and his problems.[1]

However, Schwab does not pursue consistent philosophical accounts, but instead he draws principles out of the examination of actual research reports.

> We are similarly indifferent to the original reference among philosophical commonplaces of a principle of enquiry. It may originally specify the nature of things, of method, of "mind" or knowledge without affecting its status for us as a principle of enquiry.[2]

Therefore, Schwab allows that principles of enquiry may have reference to philosophical positions. His investigations, however, clearly indicate that he is not concerned with eliciting those references. But it is clear that Schwab's five forms of principles do have some relationship to metaphysical positions.

> Of principles in this sense, we find five kinds [forms]: reductive, rational, holistic, anti-principled and primitive. Reductive, holistic, and anti-principled principles are each represented by subspecies. (The historian of philosophy will find none of these unfamiliar. Plato, Aristotle, Augustine, Plotinus, Comte, Mill, Mach, Whitehead, et al., appear to have influenced a certain number of scientists . . .).[3]

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[1] Joseph J. Schwab, "What do Scientists Do?" Behavioral Science V (January, 1960), p. 2.

[2] Ibid. [3] Ibid., p. 3.

Schwab's five forms of principles of enquiry will now be examined in terms of Pepper's world hypotheses. In some cases there is correspondence between the two. In other cases forms of principles seem to be an eclectic treatment of the categories of world hypotheses.

Reductive principles

According to Schwab, reductive principles

> rest on the notion that things are as they are because of what they are made of. A subject of enquiry is treated, not as a thing which is, but as a something constituted. The scientific account is sought in the constituents.[1]

Reductive principles are, in turn, separated into atomic reduction and molecular reduction.

> If one insists on recognizing orders of phenomena, the stage is set for atomic reductive principles. The world is seen as literally compounded, in the style of a nest of Chinese boxes. Thus physical particles constitute the organizations called chemical. Chemicals constitute each physiological. Society is the structure of physiologicals.[2]

While there may be several versions of atomic reductive principles,

> the constant mark consists in the fact that causal efficacy is wholly located in the chosen constitutive elements. The constant mark of atomic reduction consists in the fact that the efficacious elements are treated as of a different order from the constituted subject.[3]

Reductive principles can be accounted for in terms of a mechanistic world hypothesis. The primary qualities of mechanism describe the way a machine works and give insight into its reality. Essentially, the perceived secondary qualities of a machine are reductively described by the actions of primary qualities. (This distinction between non-observable and observable, or primary and secondary, qualities represents the

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[1] Ibid. [2] Ibid. [3] Ibid., p. 4.

"different order" referred to by Schwab.) Discrete primary qualities, then, are the effective aspects or elements of a machine. And, with reductive principles, "causal efficacy is wholly located in the chosen constitutive elements."[1]

Schwab describes molecular reduction as

> The effort to find the irreducible minimum of the subject-matter under investigation. Among such paradigmatic molecules we have "the family" of one political sociology, the "cell" of nineteenth century general physiology and the "two-person group" of some recent sociology.[2]

Pepper's treatment of world hypotheses provides no basis for distinguishing between atomic and molecular reduction. Both forms of reduction can be interpreted using the mechanistic categories--the difference resides in how far the reduction proceeds to the use of primary qualities in the explanation of observable phenomena.

Holistic principles

Schwab's account of holistic principles can be interpreted in terms of formism and organicism. A similarity to formism is seen at the beginning of Schwab's account.

> Holistic principles are most conspicuous in the frankly taxonomic sciences--zoology, botany, minerology--and in physiology from William Harvey to recent times. Holistic principles require an account of the subject-matter of interest in terms of the combination of qualities or constituents which as organized, sets that subject-matter apart from all others.[3]

The claim that holistic principles are conspicuous in the taxonomic sciences is a clue to the similarity between a formist world hypothesis and a holistic principle. The root metaphor of formism, *similarity*, is the basis for classification schemes. Furthermore, in formism particulars are identified either by their qualities, relations, or both. And in holistic principles the subject-matter (particular) is accounted for in terms of a unique combination of qualities.

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[1] *Ibid*. [2] *Ibid*., p. 5. [3] *Ibid*., p. 6.

However, an organicist world hypothesis is suggested in the claim that

> some properties of the constituents are sometimes treated as conferred by their place in the organization of which they are parts. For this reason, such principles are sometimes called "organic."[1]

The implication of a network or integration among the constituents is indicative of organicism. It is seen again in Schwab's paraphrase of Aristotle.

> "The fittest mode, then, of treatment is to say, a man has such and such parts because the organization of man includes their presence and because they are necessary conditions of his existence." (Paraphrased from Parts of Animals, Bk. 1, Chapter 1).[2]

Here, as with the organicist world hypothesis, parts (or fragments) are found to be implicit in the whole.

In refining the idea of holistic principles, Schwab makes a distinction between formal-material holistic principles and formal holistic principles. This is interesting because it approximates Pepper's distinction between immanent and transcendent formism. According to Schwab:

> Formal-material holistic principles follow the Aristotelian prescription in assigning roles to both the material constituents and to the organized whole.[3]

"Material constituents" here parallel the particulars of immanent formism.

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[1] Ibid. [2] Ibid., p. 7. [3] Ibid.

In formal holistic principles

> The distinguishing character of the subject of interest is treated as capable of embodiment in any one of a variety of materials or sets of parts. . . . Enquiry guided by such a view may use material parts as evidence of the character of the whole since they are taken as effects or requisites of it but the stable object of enquiry is the pattern, organization or form exhibited *via* the material.[1]

This parallels transcendent formism in which the *norm* is the focus of attention. The norm is a plan according to which things grow and are made--the norm transcends material objects. This is implicit in Schwab's idea of pattern. Reviewing Schwab's treatment of holistic principles, then, there is evidence of an eclectic combination of categories of formism and organicism, with an emphasis on formism.

Rational principles

Schwab's treatment of rational principles can also be seen as an eclectic combination of the categories of formism and organicism; only this time the similarity lies more with organicism.

> If atomic reduction seeks its likely story in "downward" terms, while moleculars and holists try for a statement of the subject in its own terms, there is a remaining malapropic possibility: reduction upward. Principles of this kind require that the subject of interest be seen as given its character by its place in some larger determinative whole or by some *ratio* imposed from without. . . .
>
> Most such principles have a distinct Platonic, Cartesian, or Deistic cast. That is, the process of determination is rarely referred to a *vera causa* or to specified processes. . . . Rather, the determiner is seen as some sort of rational structure of relations with no particular *relata* (a "configuration"), either subsisting in its own right or as the defining part of the material, determinative surround. . . .[2]

A formist world hypothesis is implied in this account to the extent to which the idea of "ratio" implies a transcendent form. Support for this implication comes from the fact that later Schwab distinguishes between rational principles and formal-holistic principles in the following way.

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[1] *Ibid*. [2] *Ibid*., p. 8.

> The distinction rests on the fact that the ratio of formal-holistic principles is something peculiar to the whole investigated while the ratio of rational schemes is a form whose variants or subspecies reign over greater reaches of investigable phenomena.[1]

This seems to be a difference in degree rather than kind, since any "greater reaches of investigable phenomena" can be construed as the new "whole investigated." It has been shown above that formal-holistic principles imply transcendent formism, if Schwab's distinction between formal-holistic ratios and rational ratios breaks down, then rational ratios also imply transcendent formism. Also, the transparency of rational ratios to formism is seen in Schwab's phrase "the ratio of rational schemes is a form."[2]

An organicist world hypothesis is implied by rational principles in the claim that the subject is "given its character by its place in some larger determinative whole."[3] This "larger determinative whole" appears very much like Pepper's treatment of the "organic whole" in which all experience is found to be successively integrated into larger and more coherent wholes. Also, in organicism, as the organic whole is reached, the system becomes more determinate--an implication of Schwab's "larger determinative whole." (Furthermore, in view of the implied organicism of the excerpt of Teilhard de Chardin's writing in the preliminary analysis,[4] it is interesting to note Schwab's claim that rational principles can have a "Deistic cast.")

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[1] Ibid., p. 9. [2] Ibid. [3] Ibid., p. 8

[4] This section of the preliminary analysis is found in Appendix II, pp. A40-A47.

Anti-principles

Anti-principles appear to be an eclectic treatment of positivism, formism, mechanism, and contextualism. The beginning of Schwab's analysis shows a positivist influence.

> The most conspicuous of anti-principles arise from and embody the familiar view that science ought to avoid principles altogether (or may avoid them without loss) and be content to report the facts. What properly constitutes "the" facts then becomes the covert issue of principle.[1]

This view is strikingly similar to Pepper's account of positivism.

> There is a theory of knowledge called positivism which appears to amount to the proposition that ideally knowledge should consist of beliefs founded on data. Empirical facts should ideally be all empirical data (pointer readings and the correlations among these). . . .[2]

Schwab distinguishes three varieties of anti-principle. The first concerns laws of nature; in addition to showing similarities to Pepper's positivist account, it contains traces of formism and mechanism.

> On the one hand, "the facts" take the form of "laws"--algebraic or verbal equations whose terms are alleged to be in one-to-one correspondence with sense-experienced and "objectively" discrete aspects of the subject-matter. Thus "facts" are the sensible covariances of measurable parameters. It should be emphasized that the mathematics involved in such enquiries is treated as a system of notation or measurement. There is abhorrence of the rationalist notion that mathematical functions express rational structures to which the world might be expected to conform.[3]

The implication in the last statement, that only particulars exist and the concomitant denial of transcendent forms, reflects mechanism. Mechanism is also reflected by the suggestion that quantitative measurement is necessary to know the "facts." Formism is implied in the idea of "correspondence" between equations and experience.

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[1] Schwab, "What Do Scientists Do?" p. 9.

[2] Pepper, World Hypotheses, p. 60.

[3] Schwab, "What Do Scientists Do?" p. 9.

Schwab describes another variety of anti-principle--causes.

> Elsewhere one finds "the facts" defined as antecendent-consequent "causation." This way of enquiring differs in no important wise from the J.S. Millsian formula. The world is seen as a web of partial uniformities whose separate strands--of invariant antecedent-consequent relations--are the only proper objects of enquiry. . . .
>
> For the purposes of an etho-psychological study of the scientist, it is useful to note that the causal anti-principle is Millsian also in the fact that it invites the "method of differences" in all its compact neatness as the basic experimental design.[1]

Here, the idea of causality as involving discrete entities or events suggests a mechanistic world hypothesis. The idea of a web of partial uniformities made of "strands" hints at contextualism.

Contextualism is more evident, however, in the last variety of anti-principle. In this variety some phenomena are considered to be so unique as to be beyond the scope of scientific investigation. This idea of uniqueness and the despair of ever finding "covering laws" relies heavily on a concept of context, which is well developed in Pepper's contextualist notions of quality, texture, spread, and fusion.

Primitive principles

Primitive principles are interesting because, while they cannot be accommodated with any particular world hypothesis, they can be accommodated within Pepper's root-metaphor theory. Schwab's treatment of primitive principles, therefore, represents a different order of analysis.

> Immature sciences and sciences in moments of frustration and regression often refresh their enquiries by renewed contact with the

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[1] *Ibid.*, p. 10.

> earth of common sense. Conceptual frames which never were or which seem to be exhausted are replaced by numerous ad hoc investigations framed in the terms of the queries which would normally speak to practical problems.[1]

Thus, primitive principles represent a return to common sense rather than the use of sophisticated guiding conceptions. Herein lies the similarity with original root metaphors. As Pepper remarks:

> A man desiring to understand the world looks about for a clue to its comprehension. He pitches upon some area of common-sense fact and tries . . . to understand other areas in terms of this one. This original area becomes then his basic analogy or root metaphor.[2]

Principles and hypotheses

Generally speaking, Schwab's forms of principles of enquiry constitute an eclectic treatment of the categories of world hypotheses. Even though the objectives, methodologies, and starting points of Schwab's and Pepper's studies are different, it is interesting to examine how we could account for the differences and similarities between their treatments.

Pepper develops the root-metaphor theory in order to explain coherent and autonomous metaphysical positions. In constructing a world hypothesis he develops categories that are consistent and mutually supportive among themselves and with the original root metaphor. In developing the root-metaphor theory Pepper emphasizes consistency and autonomy, although he recognizes eclecticism in practice. "Our general stand, therefore, is for rational clarity in theory and reasonable eclecticism in practice."[3] In practice men are eclectic--a possible explanation for the fact that Schwab's forms of principles of enquiry do not map directly onto Pepper's world hypotheses. Schwab "found" forms of principles of enquiry by analyzing scientific research reports and debates with a view to explaining differences in actual enquiries. From the perspective of world hypotheses, the enquiries Schwab analyzed are eclectic, as is Schwab's formulation.

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[1] Ibid., pp. 11-12. [2] Pepper, World Hypotheses, p. 91.

[3] Ibid., p. 330.

Conditions for Knowing

A previous study[1] by this investigator warrants review because Schwab's principles of enquiry are used and because some issues in that study stimulated the present investigation. In that study, an analytical scheme is developed for the purpose of determining the provision made in a textbook for students to infer how claims are "known." Scheffler's three conditions of knowledge--truth, evidence, belief--are used as the basis of the scheme.[2]

Truth

With reference to the requirement that the truth of claims is a condition for knowing them, the study develops three questions to be asked of claims made in a text:

> Are qualifiers present in the claim . . .? Is the claim a tautology . . . ? Which theory of truth seems to be implied . . . ?[3]

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[1] Brent Kilbourn, Analyzing the Basis for Knowledge Claims in Science Textbooks: A Method and a Case Study, Background Paper No. 6 for The Explanatory Modes Project (Toronto: The Ontario Institute for Studies in Education, Department of Curriculum, 1971).

[2] Israel Scheffler, Conditions of Knowledge: An Introduction to Epistemology and Education (Glenview, Illinois: Scott, Foresman and Company, 1965).

[3] Kilbourn, Analyzing the Basis for Knowledge Claims, p. 12.

Three traditional theories of truth--correspondence, pragmatic, and coherence--are the referents for the last question. Pepper's treatment of world hypotheses accommodates those theories respectively within formism, contextualism, and organicism.

Evidence

With reference to the requirement of evidence for knowing claims, evidence is construed in broader terms of "support."

> First, the support for claims is classified as one of four types: report of observations of states-of-affairs (evidence); reference to evidence; reference to theories, natural laws, or hypotheses; and appeal to authority.
>
> Second, the physical location of support in the text (and inclusion of a reference where appropriate) will be used to assess whether the text makes provision for the pupil to grasp that support as a portion of the "evidential argument."
>
> From this functional description of the evidence condition, two further questions of the analytical scheme are produced:
>
> What is the nature of the support for a claim?
>
> Where is support for the claim located?[1]

A concept of evidence is appropriate to formist, mechanist, contextualist, and organicist world hypotheses. Appeals to authority are appropriately associated with an animist world hypothesis. By including authority as a form of support, that previous study does not make this important distinction systematically.

Belief

The belief condition is most germane to the present study because Scheffler describes belief as "a 'theoretical' state characterizing, in subtle ways, the orientation of the person in the world."[2] A person's orientation in the world is reflected by (if not synonymous with) his world view. The final question for the scheme developed in that previous study is What "beliefs" provide a basis for a claim?[1]

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[1] *Ibid.*, p. 16. [2] Scheffler, *Conditions of Knowledge*, p. 90.

> It is a basic assumption for this study that knowledge claims in science textbooks are presented as "known" by the scientific community. To determine whether a text provides for a pupil to infer how these claims are known requires that we consider "the scientific community's" basis for knowing them. One way to address this problem is to postulate that there are "beliefs" held by the scientific community which provide a basis for making knowledge claims. These beliefs can be regarded as the scientific community's "orientation in the world," and they provide a way of looking at and interpreting phenomena.[2]

Such "beliefs" are categorized according to belief in inferential techniques, belief in theory, and belief in principles of biology.

The last category, principles of biology, has been developed and used by Connelly[3] and consists of more specialized (i.e., biologically oriented) principles of enquiry in Schwab's sense of the term. There are three biological principles: structure-function, antecedent-consequent event, and regulation. These principles of enquiry are used as one way to characterize "beliefs" of the scientific community.

Beliefs and world hypotheses

Two issues which develop from the investigator's previous study show its relationship to the present study. First, while no attempt is made (in the previous study) to link theories of truth with principles of enquiry, it is clear that the development of those links would be significant in showing the complexity of the basis for knowledge claims. Pepper's work is important in this regard because he does postulate links between theories of truth and world hypotheses.

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[1] Kilbourn, Analyzing the Basis for Knowledge Claims, p. 23.

[2] *Ibid*., p. 17.

[3] F.M. Connelly, "The Structure of Plant Ecology with Special Reference to the Ecosystem Concept" (unpublished Ph.D. dissertation, University of Chicago, 1968).

Second, reflection on the scientific community's "orientation in the world" suggests that more encompassing considerations than biological principles of enquiry, theories, or inferential techniques are operative in most circumstances. It seems, for example, that an enquirer's total world view has influence in shaping the nature of enquiry. Pepper's work is helpful in that it provides a way of conceptualizing these more encompassing considerations.

Epistemological Posture

Campbell's study introduces a new psychological construct related to world view. The construct, *epistemological posture*, means "the attitudes and beliefs concerning the nature of truth and knowledge which a person holds--whether consciously or unconsciously, in well organized or disorganized fashion. . . ."[1] Campbell contends that epistemological posture is an intellectual variable in that it represents "a factor or dimension of an individual's *Weltanschauung* or world view--the conceptual structure in which an individual organizes his perceptions of the world."[2] The essence of Campbell's study is the development of a preliminary taxonomy of epistemological posture, and it shows a feasible approach to the measurement of this intellectual variable.

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[1] Douglas C. Campbell, *Epistemological Posture as an Intellectual Variable*, Background Paper No. 3 for The Explanatory Modes Project (Toronto: The Ontario Institute for Studies in Education, Department of Curriculum, 1971), p. 1.

[2] *Ibid.*

The taxonomy consists of twenty-three issues stated as questions. Possible answers to these questions represent alternative positions with regard to the issues. As might be expected, a number of the issues intersect the domain of world hypotheses. One of the more obvious intersections occurs with the following question and positions:

> What are the criteria (of validity) of truth?
>
> The coherence theory: absence of self-contradiction; absence of inconsistency with logical matrix in which truth is embedded; its necessity as a constituent of a systematically coherent whole; complete consistence with logical matrix in which truth is embedded; tautological structure.
>
> The correspondence theory: correspondence between elements in the proposition and elements in the "real world," by reference to sense data (empirical verification).
>
> The pragmatic theory: "usefulness" in practice; "workability" in practice; "satisfaction" in use; concepts defined operationally and the appropriate operations successfully carried out; predictive efficacy or reliability; persuasive efficacy; demonstrated capacity to withstand tests or challenges.
>
> "Self-evidence:" its negation is not conceivable; constituent of "conventional wisdom;" coherence with intuition (insight).
>
> Issuance from authoritative source: religious document, institution, or leader; political agency or leader; intellectual leader or other "expert" source.
>
> Feeling of confidence, certainty, or conviction: simple acceptance; feeling of commitment.
>
> Embedded in tradition: cultural heritage; general public agreement.
>
> Meets moral criterion: what ought to be.
>
> Fulfills expectations.

> There are multiple kinds of truth, not just one kind; each kind is distinct from the others and has its own set of criteria.[1]

The first three theories of truth are represented in organicism, formism, and contextualism, respectively. "Self-evidence," "intuition," "certainty" are represented in mysticism. "Authoritative source" is represented in animism, while "what ought to be" reflects formism. "General public agreement," "fulfills expectations," and "multiple kinds of truth" are consistent with contextualism.

In his study Campbell emphasizes that

> "epistemological," as used in this paper, is not intended to connote the subtle and complex issues which comprise that branch of professional philosophy known as epistemology. The term is intended, rather, to connote the "naive epistemology" (akin to Piaget's "naive metaphysics") that one would expect to find in the lay public among people unschooled in the technical issues and methods of working philosophers.[2]

Therefore, there is a striking contrast between Campbell's work and Pepper's in that Pepper is concerned with consistent philosophical positions as expressed by philosophers, whereas Campbell wants to measure the eclectic positions of the lay public. In this respect, Pepper's work is potentially useful as a background for seeing positions of the lay public as being eclectic.

Views of Science

Munby has developed a two-part scheme for analyzing science teaching. The first part presents a way to determine whether teaching provides for intellectual independence or intellectual dependence. Portions of Munby's argument on this point have been used to elaborate a concept of teaching in Chapter I of this study. Of major interest here is the second part of Munby's scheme: a way to determine what "view of science" is provided for in science teaching. This part of the scheme is most relevant to Pepper's world hypotheses.

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[1] *Ibid.*, pp. 13-14. [2] *Ibid.*, p. 1.

Munby uses Nagel's treatment[1] of instrumentalism and realism as a basis for developing a perspective which indicates views of science. Munby's treatment of the two positions can be summarized as follows:

> Instrumentalist view: theories are conceptual devices, being neither true nor false; the "scientific objects" of theories are theoretical entities and do not have an existence in the external world.
> Realist view: theories are statements which are either true or false; the "scientific objects" in such statements exist in reality.[2]

These two positions can be accommodated within Pepper's approach to world hypotheses. The Instrumentalist view is similar to contextualism in that schemes (maps, diagrams, formulas, functional equations, symbolic systems, and "scientific objects") are considered in contextualism to be instruments of man. Rather than affording a perspective on reality, these instruments must be seen in the context of human action--prediction, control, and explanation. (Pepper notes that "those who call themselves instrumentalists among contextualists give these references [instruments] a dominant position among the categories.")[3]

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[1] Ernest Nagel, The Structure of Science (New York: Harcourt, Brace and World, Inc., 1961).

[2] A. Hugh Munby, "The Provision Made for Selected Intellectual Consequences by Science Teaching: Derivation and Application of an Analytical Scheme" (unpublished Ph.D. thesis, University of Toronto, 1973), p. 88.

[3] Pepper, World Hypotheses, p. 260.

Munby's Realist view can be interpreted through formism and mechanism; that is, these two world hypotheses have a "Realist" orientation. In mechanism, while a distinction is made between primary and secondary qualities, the primary qualities (Munby's "scientific objects") are considered essential to the description of a machine and give insight into its reality. Within formism, "scientific objects" are forms of matter and as such have an existent reality which is also consistent with Munby's Realism.

Munby's concepts are limited to views of science and hence are more narrowly conceived than Pepper's encompassing notion of world hypotheses. However, in developing a perspective for dealing with views of science, Munby examines two explanatory paradigms and makes this comment.

> The paradigms are examined to reveal how each implies a different view of science (as the way to explain or as a way to explain), and to show that pupils can derive a different view of science itself and a different view of the world, from each.[1]

It is clear that Munby sees the potential for a view of science to contribute to a student's view of the world. Pepper's approach to world hypotheses has potential as a more elaborate way of conceptualizing these views of the world.

Argument and Authority

Russell has used Toulmin's "argument-pattern" in examining teacher arguments to demonstrate that the form of these arguments can imply different concepts of authority.[1] He concentrates primarily on Toulmin's pattern (data, conclusion, warrant, backing)[2] to analyze science lesson transcriptions, and accordingly his study intersects world hypotheses.

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[1] Munby, "The Provision Made for Selected Intellectual Consequences by Science Teaching," p. ia.

> Toulmin first distinguishes between the claim or Conclusion (C) and the facts or Data (D) which support the claim. His second distinction identifies statements of the type "Given data D, one may take it that C." Such statements are referred to as Warrants (W) for their function of justifying the move from Data to Conclusion.[3]
>
> In addition to the question whether or on what conditions a warrant is applicable in a *particular* case, we may be asked why *in general* this warrant should be accepted as having authority. . . . Standing behind our warrants, . . . there will normally be other assurances, without which the warrants themselves would possess neither authority nor currency--these other things we may refer to as the *backing* (B) of the warrants.[4]

It is Toulmin's notion of "Backing" which intersects with a concept of world hypotheses. Backing "may be a statement of fact. . . ."[5] But Pepper's work shows quite clearly that world hypotheses influence what is considered to be "fact." Therefore, in some cases the Backing for a Warrant may consist of a conceptual perspective or world hypothesis.

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[1] Thomas L. Russell, *Toward Understanding the Use of Argument and Authority in Science Teaching*, Background Paper No. 7 for The Explanatory Modes Project (Toronto: The Ontario Institute for Studies in Education, Department of Curriculum, 1973).

[2] Stephen Toulmin, *The Uses of Argument* (Cambridge: Cambridge University Press, 1958).

[3] Russell, *Toward Understanding the Use of Argument and Authority in Science Teaching*, p. 6. Capitalization of the first letter of terms representing elements of Toulmin's argument-pattern is consistent with Russell's usage.

[4] Toulmin, *The Uses of Argument*, p. 103.

[5] Russell, *Toward Understanding the Use of Argument and Authority in Science Teaching*, p. 8.

This can be seen in the following.

> Toulmin presents three Warrants which might be used to move from Datum to Conclusion in an argument: (1) "A whale will be a mammal.", (2) "A Bermudan will be a Briton.", and (3) "A Saudi Arabian will be a Muslim." He then points out how very different are the Backings which can authorize these three Warrants. The first Warrant is supported by a scheme of taxonomic classification, the second Warrant is based upon a particular set of legal statutes, and the third Warrant is backed by statistics which relate nationality and religious beliefs.[1]

In the first case, for example, the Warrant is not only supported by a scheme of taxonomic classification, it is also supported by the formist world hypothesis, the root metaphor of which forms the basis of classification. Deny the intuition of similarity and the Warrant "A whale will be a mammal" will not be supported. Thus, Pepper's approach to world hypotheses can serve as a more encompassing treatment of Backing.

Summary

Six studies related to the present investigation have been examined in this chapter. In each case, the conceptual framework of the study examined is shown to be related to the conceptual framework developed by this investigator in Chapter II, based on Pepper's approach to world hypotheses. Further, it is seen that in spite of the fact that each study examined here has a conceptual framework related, though not centrally, to aspects of the concept world view, Pepper's approach to world hypotheses is relatively more adequate for purposes of the present study.

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[1] Ibid., p. 9.

CHAPTER V

A CASE-STUDY APPLICATION OF THE SCHEME: QUALIFICATIONS, CONDITIONS, AND LIMITATIONS

Introduction

As noted in Chapter I, this study has three distinct argumentative steps. The first, development of a conceptual framework based on Pepper's World Hypotheses, has been completed in Chapter II. Demonstration of the significance of that conceptual framework for confronting certain contemporary curriculum issues, the second step, has been accomplished in Chapter III, and related research has been examined according to that conceptual framework in Chapter IV. The final argumentative step remains. The conceptual framework is used as a scheme for analyzing science teaching materials, in order to consider its usefulness as a tool for examining one of the realities of science education: the materials used by learners.

Systematic analysis of teaching materials is extremely complex, both methodologically and substantively. For that reason, claims made about the usefulness of any analytical scheme must be qualified carefully. Here the claim is made that the scheme can be used to detect world hypotheses projected by written material (in this case a biology textbook). Qualifications on that claim, and especially the conditions under which it can be said that world hypotheses are projected by written material, are to be articulated here as precisely as possible. These, of course, constitute certain limitations on this portion of the study; others arise from limitations of Pepper's work itself, and are noted.

This chapter has four parts. The first, "Scope of the Analysis," outlines the nature of the information to be obtained from this case-study application of the scheme. The second, "Analytic Conditions," discusses substantively the way in which the information is obtained. The focus is on development of the concept of projection. Also, this part deals with several theoretical and methodological problems, especially those involved in specifying a unit of analysis. The third part, "Notes in Advance of Reading the Analysis," prepares the reader for detailed examination of the analysis itself. It delineates how the analysis has been done in light of the first two parts of the chapter, and provides information about the way the analysis is presented.

The first three parts of the chapter implicitly and explicitly point out some of the limitations of this portion of the study. The fourth part, "Critique of World Hypotheses," discusses limitations imposed by using Pepper's work as the basis for the conceptual framework developed in this study. The investigator contends that Pepper's work can certainly be applied to curriculum problems, as seen in Chapter III, but that it cannot be accepted uncritically. Accordingly, this concluding part of the chapter briefly reviews published criticism of World Hypotheses. Arising in part from this criticism is the investigator's own critique of selected aspects of Pepper's treatment, which is meaningful only after the reader has examined the analysis itself.

Scope of the Analysis

The exploratory nature of this study has been discussed in detail in Chapter I. The analysis which constitutes this portion of the study is limited to examination of a single biology textbook. The results of applying the scheme to that textbook appear in Appendix IV, to which the reader's attention is directed at the appropriate point later in this chapter. Discussion of the analysis is reserved for Chapter VI and is centered around questions concerning usefulness of the scheme in the overall context of this study.

Selection of the textbook

The investigator chose a biology textbook for three reasons. First is the consideration that a biology textbook would provide a larger data base for reflecting on the application of the scheme than would, say, a textbook in the physical sciences. Thus, one might typically expect to find more organicist assumptions underlying knowledge claims in biology than knowledge claims in physical sciences. And classification, involving concepts of ideal types, assumes characteristics of formism--a situation perhaps less likely to be found in the physical sciences than in biology. Still, because of the intimate relationship between molecular biology and the physical sciences, one might also find elements of mechanism and contextualism projected in a biology textbook.

Second, a biology textbook was selected because the discussion of man as a biological phenomenon is commonplace in general biology textbooks. Man is often the focus of discussion as an exemplar of biological phenomena and as a species fitting into the community of living things. Inasmuch as social issues center on man, the choice of a biology textbook, describing aspects of man, adds to the significance of this study.

Finally, a pragmatic reason for analyzing a biology textbook is that the investigator is familiar with substantive issues in biology, which is helpful when reflecting on whether some world hypotheses are associated with substantive issues in biology (one question guiding this portion of the study, as noted below).

The textbook to be analyzed was selected from among the six approved in Ontario as student textbooks and supplementary references for Grade 13 general biology.[1] Each was assigned a number, in order of its presentation in *Circular 14*. The titles and bibliographic details of the textbooks, together with their assigned numbers, are as follows.

1. Biological Sciences Curriculum Study, *Biological Science: An Inquiry into Life [BSCS Yellow Version]* (2nd ed.; New York: Harcourt, Brace & World, Inc., 1968).
2. Biological Sciences Curriculum Study, *Biological Science: Molecules to Man [BSCS Blue Version]* (rev. ed.; Boston: Houghton Mifflin Company, 1968).
3. D. Galbraith *et al.*, *Biological Science--Principles and Patterns of Life* (Toronto: Holt, Rinehart, and Winston of Canada, Ltd., 1966).
4. D. Penny and R. Waern, *Biology* (Toronto: Sir Isaac Pitman [Canada], Ltd., 1965).
5. F.M. Speed, *General Biology* (Columbus, Ohio: Charles E. Merrill Books,

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[1] Ministry of Education, Ontario, *Textbooks: Circular 14, 1972*, pp. 77, 90.

Inc., 1966).

6. Biological Sciences Curriculum Study, High School Biology [BSCS Green Version] (2nd ed., Chicago: Rand McNally & Company, 1968).

A random numbers table was used to make the selection from this list. The textbook thus selected for analysis in this study is General Biology by F.M. Speed.

Information sought

Conclusions drawn in this portion of the study are limited to aspects of applying the scheme. There is no attempt to make generalizations concerning the extent to which one world hypothesis is projected, as compared with others. For example, there is no attempt to make a claim about *which* world hypothesis is projected predominantly in Speed's General Biology. Furthermore, there is no attempt to make similar claims with regard to biology textbooks or science textbooks in general. Nor is this study concerned with determining what *effects* projected world hypotheses have on students.

Claims of that kind would, of course, be relevant to the issues discussed in Chapter III--issues concerning the significance of this study. It would be very useful, for example, to find out whether a mechanistic world hypothesis is implicit in most science textbooks used in schools in North America, and whether students are affected in specific ways by mechanism. Such information would be crucial to deliberations about curriculum change, in view of the social problems discussed in Chapter III.

However, the kinds of conceptual problems which this study deals with are prior to applications like these. To be sure, if projected world hypotheses had no effect on students, the significance of this thesis would be severely undermined. The investigator assumes that they have some effect, but tests of that assumption are beyond the scope of this study and also have little meaning unless the assumption is first clarified conceptually.

Three questions

Three questions give structure to the information sought in this portion of the study. These focus the reflection and commentary on the analysis.

First, in what ways are messages about world hypotheses presented to students? For example, are world hypotheses always projected implicitly, or is a framework provided for making the student aware that claims are stated from within a conceptual perspective?

Second, are some world hypotheses associated with underlying issues in the textbook? For example, are some world hypotheses associated with substantive issues in the discipline of biology?

Third, what difficulties are encountered in the application of the scheme? This question concerns, for example, inherent ambiguity in the world hypotheses or the sections analyzed which makes a "judgment of projection" difficult. Or, it could involve problems that develop from the stipulative definition of projection, or from context, or from the unit of analysis. Such potential difficulties have to do with the conditions of the analysis--that is, the conditions under which claims made about the usefulness of the scheme can be substantiated.

Analytic Conditions

Five conditions of the analysis are discussed in this section. First is the specification and justification of the concept of projection. Following this is a discussion of appropriate methodological conventions. The next portion outlines what constitutes an argument that a world hypothesis is projected. Then, arising from considerations of projection, there is discussion of an attitude appropriate to analyzing material. Finally, there is an examination of the problems involved in specifying a unit of analysis.

Projection

It is assumed in this study that world views implicit in written material potentially affect students. A model for this interaction includes the idea that there is some "meaning" that "is given" to the student in written material, and further that the student has the capacity to "pick up" this meaning and incorporate it into his existing conceptual structure. On the one hand, then, there is written material which contains meaning (describable in terms of world views as conceptualized in Pepper's world hypotheses), and which thus participates in "giving" meaning. On the other hand, there is the student whose potential active role in the process is "uptake" of that meaning.

This model is useful for clarifying a claim that world hypotheses are projected in written material. The present study concentrates on only one element of the process--textual material and its meaning against the background of world hypotheses. Despite the importance of considering the other element--i.e., students' interpretations of science textbooks which they read--it is beyond the scope of this study to do so.

It is assumed, then, that there is some "meaning" more or less inherent in written material which is "thrust out," "given," or "extruded" and has the potential for being "taken up" by a student. In Chapter I this investigator has proposed the term projection to capture this quality of "meaning-giving" by written material; accordingly, written material can be said to project a world hypothesis. An appropriate definition for projection is now stipulated to account for the specific requirement that must be met if the term is to be useful for purposes of this study.

The requirement

A concept of projection is needed which presents a continuum for analyzing material that strongly suggests a world view to material that weakly suggests a world view. In other words, a concept of projection is required which will cover cases where a world view is explicitly expressed (e.g., Pepper's description of a mechanistic world hypothesis is explicitly expressed), and which will cover cases where material vaguely implies a world hypothesis but nevertheless does seem to project some world hypothesis.

This requirement is reasonable since a continuum respects the fact that the impact with which world hypotheses are perceived might depend upon the student as reader. As noted above, the thrust of this study is not to find out what the student as reader does in fact "pick up" from verbal material. Nevertheless, it is recognized that the study derives its significance from this empirical issue, and that too narrow a definition of projection might severely limit the usefulness of the concept. This is taken into consideration in developing the following stipulative definition of projection.

Stipulative definition of projection

The justification for the following definition of projection is that it provides clarity and incorporates requirements considered useful for a reasonable analysis of a science textbook. A section is judged to project a world hypothesis if any or all of three conditions hold:

(1) if the section overtly expresses a world hypothesis. The following statements provide an example.

> The time has come to realize that an interpretation of the universe--even a positivist one--remains unsatisfying unless it covers the interior as well as the exterior of things; mind as well as matter. The true physics is that which will, one day, achieve the inclusion of man in his wholeness in a coherent picture of the world.[1]

These statements are judged to project an organicist world hypothesis because of the stress on wholeness, inclusiveness, and coherence. The projection is overt in the sense that the issue discussed concerns hypotheses about the nature of reality. For a section to overtly project a world hypothesis, it need not necessarily be stated in Pepper's terminology, but does need to express views directly about interpreting the nature of reality.

(2) if a world hypothesis must be assumed for the section to be intelligible. For example:

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[1] Pierre Teilhard de Chardin, The Phenomenon of Man (London: Wm. Collins Son & Co., Ltd., 1959), p. 40.

> All recent experimental evidence indicates that nucleic acids are the molecules that exert primary control over the life processes of all living organisms.[1]

The mechanistic world hypothesis behind this statement is not expressed overtly. Portions of that world hypothesis entail the notion that observable phenomena in the world (in this case, life) can be explained by (accounted for, reduced to) the interactions of discrete particles (molecules, atoms, electrons) which have location in time and space. To reject this assumed position renders the statement unintelligible (possibly meaningless, at least inconsistent).

(3) if the section implies a world hypothesis (yet it cannot be readily demonstrated that the hypothesis must be strictly assumed for the statement to be intelligible). Again, an example:

> Possibly you will be surprised that the data of biology can be united in a theory. That is, all the facts can be seen as part of a unified whole.[2]

Because of the reference to a "unified whole" these statements would be judged to project an organicist world hypothesis. Yet, although the statements tend to imply this hypothesis, it is difficult to imagine that denial of the organicist position renders the statements unintelligible.

Methodological conventions

It is necessary to elaborate two methodological conventions, adopted for the analysis, which help clarify the idea of projection. The first concerns what is meant when it is said that a statement projects a world hypothesis. Each world hypothesis has a number of identifying features; it is unreasonable to expect that all of these could be projected by a single section of text. Hence, the convention is that projection of a world hypothesis is asserted if at least one identifying feature of that hypothesis is projected in a section.

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[1] BSCS, Biological Science: Molecules to Man, p. 215.

[2] BSCS, Biological Science: An Inquiry into Life, p. 721.

The second convention develops from the investigator's notion of logically primitive characteristics of world hypotheses. Logically primitive characteristics are either explicitly stated for a world hypothesis or are implied directly by its root metaphor, categories, or theory of truth. (Pepper, of course, explicates each world hypothesis only in terms of its logically primitive characteristics.) If a section of text could be interpreted as projecting more than one world hypothesis, the convention is that a judgment is made strictly on the basis of logically primitive characteristics.

The need for this convention originates in the consideration of Pepper's claim that "adequate" world hypotheses are so by virtue of the fact that they can account for most phenomena put before them, including characteristics of other world hypotheses. Two examples will be of assistance. First, an organicist's intuition of integration can be accounted for in terms of mechanism, formism, or contextualism; second, the mechanist's penchant for quantification can be accommodated within organicism, formism, or contextualism.

In the first example, despite the fact that three other world hypotheses could account for a concept of integration, the basis for saying that integration is an identifying feature of organicism (and not another world hypothesis) is that it is a logically primitive characteristic of organicism. (It is the root metaphor of that world hypothesis.) In the second example, quantification is considered an identifying feature of *mechanism* (and not one of the other world hypotheses) because quantification develops directly from the effort to specify the efficient parts of a *machine* (e.g., location and mass). Machine is the root metaphor of mechanism, and quantification is implied directly by it; hence quantification is a logically primitive characteristic of mechanism.

With these two examples in mind, consider a problem which arises in the analysis of written material. Again a specific example is helpful: a situation in which reference to quantification in the written material is used as the basis for judging that mechanism is projected. The use of quantification is not inconsistent with, say, an organicist account. But quantification is not a logically primitive characteristic of organicism (or formism or contextualism). Hence the judgment that mechanism is projected.

The justification for this convention is that it allows claims of projection to be made on the basis of written material alone. An alternative convention would be to determine the author's conceptual perspective and let that be the context in which all judgments would be made. Another convention would be to let a student reader's perceptions of what is projected serve as the context in which judgments are made. Resorting to the "author's position" or to a "student reader's perception" are both beyond the scope of this study.

Argument

In the analysis, of course, claims of projection must be supported by an evidential argument which tells why a section is judged to project a particular world hypothesis. The form of the argument is that one or more characteristics of a world hypothesis must correspond to one or more elements of the section analyzed. From this it is evident that a section could project more than one world hypothesis. For example, both mechanism and formism are projected in the following paragraph.

> The musculature of the limbs of amphibians and terrestrial vertebrates such as lizards, birds, and mammals follows a similar pattern where the operation and attachment of muscles are concerned. In all cases the skeletal muscles are arranged in antagonistic pairs--when one contracts, the other relaxes. One of these muscles bends the limb and is called the _flexor_; the other straightens the limb and is known as the _extensor_.[1]

Mechanism is projected in this paragraph because of the assumption of the principles of a lever for muscle operation. Formism is projected because of the assumption of the formist root metaphor (similarity) in the claim that "the musculature . . . follows a similar pattern."

Attitude

There is an appropriate attitude to be taken when using the analytical scheme, which qualifies claims of projection. It is expressed during the analysis by asking what world hypothesis best accounts for what is stated. This attitude formally recognizes that seldom is there a "correct answer" concerning claims of projection. For example, in ambiguous cases there is clearly the chance that different world hypotheses may be judged as being projected. And, it is easy to imagine that in these cases the conceptual perspective of a reader might contribute to his idea of what is projected. For instance, we could suppose that material projects a holistic perspective, but is ambiguous as to whether contextualism or oganicism is projected. (It is always possible, in cases of this sort, that there is not enough information present in the material to make a judgment about *which* world hypothesis is projected.) It is plausible that if a reader's own conceptual perspective tended toward organicism, he may judge the material as projecting organicism in this case.[1]

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[1] Speed, _General Biology_, p. 4.

Consequently, the attitude of seeking a "correct answer" to the question of projection is misleading. Rather than ask "Which world hypothesis *is* projected in this section?", an appropriate attitude is *"Which world hypothesis best accounts for what is said in this section, and therefore we shall say that the section projects that hypothesis?"* This attitude to be taken during the analysis, and the concomitant clarification that it gives to *projection*, effectively reduces the gravity of the dilemma about "knowing" the *correct* analysis of a section. It does so by putting claims about projection in terms of reasonable judgments to be argued for within the conditions of the analysis, namely projection, methodological conventions, argument, and attitude.

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[1] It is not assumed that people "have" one or another of Pepper's world hypotheses incorporated in their conceptual structures. It is assumed that they use some conceptual perspective (probably not systematic) which can be analyzed using world hypotheses.

Unit of Analysis

The last analytic condition left for discussion is the specification and justification of a unit of analysis. The operational aspect of this analysis is the making of judgments, based on argument, about world hypotheses projected in written material. Those judgments, of course, are about specific pieces of material--units of analysis. There seem to be at least two avenues which can be pursued in specifying a unit of analysis. The unit could be rigid. That is, a specific unit (e.g., sentence) could be prescribed. If a sentence were the unit of analysis, then each sentence would be examined systematically to see which world hypothesis was projected.

On the other hand, the unit could be flexible, as it is in this study. Accordingly, the unit analyzed is sometimes a paragraph, other times a sentence, several paragraphs, and so on. For this study the flexible unit of analysis is called a section, and the choice of how much material the section includes is determined primarily by considerations of context (as discussed below).

The specification of a rigid unit of analysis would provoke or increase difficulties which are not so serious if a flexible unit is specified. Further, it is argued below that, while the flexible unit of analysis may be a paragraph, sentence, phrase, etc., the substantive unit of analysis is clearly defined as that portion of material (within the flexible unit) corresponding to some characteristic of a world hypothesis. In other words, a generalization may be made about, say, a paragraph, such as "this paragraph projects world hypothesis X."

However, the claim of projection refers only to those portions of the paragraph that correspond to characteristics of world hypothesis X.

Rigid unit of analysis

There are attractive features to the specification of a rigid unit of analysis. One of these is "procedural consistency." As an example, suppose that sentence had been specified as the basic unit of analysis. In that case, there would be no question about the material to which a claim of projection refers. Procedurally this would be convenient, if a consensus were sought among independent investigators on a sample of material, since each investigator would be analyzing the same sentences. If disagreement occurred, it would not be due to the use of different units of analysis, but could be attributed to different judgments about specific sentences. In short, the specification of a rigid unit of analysis is attractive because it would promise a certain degree of procedural consistency in the application of the scheme.

A second attractive feature of specifying a rigid unit of analysis is that it would render the results of the analysis suitable for quantification. Given a sample of written material which contains a finite number of sentences, it would be possible to tell how many sentences project particular world hypotheses. In fact, both features of specifying a rigid unit of analysis (procedural consistency and quantification) are attractive because they permit quantitative questions to be answered about a given textbook. For example, a question, such as, Which world hypothesis is projected to a greater extent in Speed's biology textbook?, requires a quantifiable technique if the question is to be answered rigorously. The same holds for a question such as, What world view does Speed's textbook project?

It is important to remember, however, that no attempt is made to answer quantitative questions of that sort as a result of this exploratory analysis. Hence a rigid unit of analysis need not be adopted. While this in itself is a valid point, a more important reason for not specifying a rigid unit of analysis is found in difficulties arising out of the specification of pertinent context. To this we shall turn now.

Context for sentences

The substantive difficulties arising from the use of a rigid unit of analysis concern context. Unless otherwise indicated, context for this study refers to written material within the text adjoining the portion analyzed. It does not normally refer to factors extraneous to the text such as culture, geographical area, or social strata. Consequently, if a sentence were the unit of analysis, then other sentences in the paragraph (chapter, unit, textbook) would be considered context.

One problem with an analytical procedure which uses a rigid unit of analysis is that there is little opportunity to honor idiosyncrasies of the analyzed sample. Such idiosyncrasies could arise from the subject matter, writing style, or nature of the argument. Another serious problem with a rigid unit of analysis such as a sentence is that it ignores the interrelatedness of different sentences. The assumption that each sentence can be analyzed as a separate entity ignores the fact that sentences impart meaning to each other in complex ways; they are not read in isolation. The following example from the analysis illustrates this point.

In the introduction to Chapter 4 of Speed's textbook ("The Anatomy of the Cell"), a brief historical account of the development of cell theory mentions various investigators in this field. Among these is Swammerdam, and the following comment is made.

> Unfortunately, Swammerdam became convinced that his studies of these hitherto invisible forms of life were uncovering the secrets of life known only to the Creator and he burned all his sketches and destroyed his microscopes.[1]

This sentence, if analyzed in isolation, says little with regard to projected world hypotheses. The term "unfortunately" suggests a judgment on the part of the author that Swammerdam's action was misguided or represents an historical loss. On the other hand, if the statement is read within the context of the entire introduction or the entire chapter, it acquires more meaning. Later in the introduction emphasis is given to the importance of the microscope and the study of microstructures for understanding the cell. We find sentences like the following.

> The invention of the electron microscope just before World War II heralded a major breakthrough in biology.[2]
>
> The magnification afforded by the electron microscope made it possible to study the cell in far greater detail than was once thought possible. Now, instead of guessing the structure of the smaller cell bodies, biologists can examine them in fine detail.[3]

These contribute to the projection of mechanism because of a tacit assumption that explanations of the cell can be reduced to smaller microstructures--mechanistic reductionism. And in fact the entire chapter tends to project mechanism in the sense that various cell structures (cell membrane, cell walls, ribosomes, etc.) are described in terms of inferred particles such as molecules.

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[1] Speed, General Biology, p. 35. [2] Ibid., p. 37. [3] Ibid.

Given this context the sentence concerning Swammerdam acquires more meaning. We can be more confident of the obvious claim that it projects a bias against animism because of the general tendency of the immediate context to project a mechanistic world hypotheses. (There is an historical controversy in biology between mechanism and animism, the latter in the form of "vitalism.") It is difficult to separate the sentence from its context in any event, and it has been shown above that analysis is enhanced by regarding a section (e.g., a paragraph) as a whole in which the individual parts (e.g., sentences) contribute to the meaning of the whole in complex ways. The analysis of the whole cannot be reduced to an analysis of separate parts. A fatal shortcoming of specifying a rigid unit of analysis is that the whole which is most meaningfully analyzed does not always correspond to some chosen rigid unit.

Context and a reader

A further consideration involving context concerns the likelihood that what context is regarded as important might well depend on a student reader's conceptual perspective. Material that is understood as peripheral context (or ignored) by one reader might serve as the framework through which the rest of the section is interpreted by another. And the emphasis given to various sections or portions of sections by different individuals is undoubtedly in part a product of individual world views, as has been suggested.

Again, it is important to remember that focusing on the role played by a student reader is beyond the scope of this study. Nevertheless, some anticipation of that role is necessary for defensible delineation of the conditions of the analysis. What is and is not considered context clearly depends on the idiosyncrasies of both the material and a reader. In the case of the latter, the specification of a rigid unit of analysis cannot honor a reasonable anticipation of what context a reader might regard as relevant to a section of text.

Flexible unit of analysis

Many of the problems just mentioned are less serious if the unit of analysis remains flexible, as in this study. Sometimes the section analyzed is a single sentence, especially if it projects a world hypothesis particularly strongly. At other times the section analyzed is an entire subtopic,[1] or a paragraph or, as in two cases, an entire chapter. The primary rationale for a flexible unit of analysis is that it permits the investigator to treat sections as wholes.[2] And it respects the fact that some sections (representing a "whole") may be larger than others. For example, the last chapter of Speed's textbook ("The

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[1] A subtopic is a chapter "section" in Speed's textbook. The word "section" is not used there in the technical sense in which it is used in the present discussion, of course.

[2] It must be clear from this discussion that the investigator's bias is holistic rather than reductionistic. Nevertheless the argument presented here for a flexible unit of analysis is compelling on its own terms, in the investigator's judgment.

Interdependence of Organisms") contains elements which project formism, mechanism, contextualism, and organicism. But the argument for the projection of organicism is convincing only if the chapter is examined as a whole.

Substantive unit of analysis

The analysis is no less rigorous because the unit of analysis is flexible rather than rigid. This is so because a claim of projection, strictly speaking, refers only to that portion of the section corresponding to some characteristic of a world hypothesis. For example, the following consists of two consecutive paragraphs from an eight-paragraph section titled "Inorganic Substances."

> All matter in the universe, including the substance of living things, is composed of 88 naturally-occurring *atoms* (plus their isotopes) which range in size from the lightest and simplest, hydrogen, to the largest, uranium. Since elements are pure substances composed of only one kind of atom, there must be 88 naturally-occurring elements. Besides the 88 natural elements there are four short-lived ones that should occur in nature but have so far only been witnessed in the laboratory. In addition to these are another 11 man-made elements bringing the total to 103 in all. The *physical properties* of these elements--boiling and freezing points, density, and physical state--depend on the way in which these atoms are arranged. Similarly, the chemical properties of these elements are dependent on the structure of the atoms that form their smallest parts. All chemical reactions between elements depend on the behavior of sub-atomic, negatively-charged particles called *electrons*. Whether the reaction is a slow one involving the rusting of iron, or a rapid one resulting in a violent chemical explosion, it is the behavior of electrons in the outer regions of atoms that determines the nature of the reaction. The driving force behind all chemical reactions, whether inorganic or organic, is the need of all atoms to achieve stability in these outer regions.
>
> No one knows what an atom or an electron looks like. This means that the diagrams of atoms which appear in this and other texts are unreal. Nevertheless, these diagrams,

> which in the text indicate electrons arranged in energy levels around a positive nucleus, represent possibly the best understood model and, more important, enable us to discuss simple chemical reactions.[1]

The section here could as well have been the entire eight paragraphs, or the passage could have been split into two sections, each one paragraph long. In this particular case the entire eight paragraphs were read, and it was decided that after the first two paragraphs there was no remaining material which provided anything new or interesting--an analysis of the remaining six paragraphs would be redundant. (It must be remembered that the purpose of the analysis is to demonstrate the use of the scheme, not to acquire quantitative data for making generalizations about what world hypothesis the textbook projects.)

In the analysis of these two paragraphs it is claimed that this section projects mechanism and contextualism. This claim provides the reader with some advance idea of the nature of the detailed analysis in Appendix IV, but it is more important here to identify those aspects of the section that provide the basis for making a claim of projection: the substantive units of analysis as they are called. Substantive units of analysis are the specific portions of the section that are judged to correspond to one or more characteristics of a world hypothesis. The following quotation from the analysis (Appendix IV, p. A65) shows that in fact only portions (phrases and sentences) of the section are analyzed, and that these substantive units are what the claim of projection strictly refers to.

> The claim that "all matter in the universe, including the substance of living things, is composed of 88 naturally-occurring

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[1] Speed, General Biology, p. 12.

atoms . . ." (lines 1-2) projects a mechanistic world hypothesis because the description of "matter in the universe" is in terms of discrete atomic particles. This description includes "the substance of living things" (lines 1-2). Further description of matter in the universe includes the explanation of chemical reactions according to the interactions of particles: e.g., "the driving force behind all chemical reactions . . ." (lines 21-22). These statements indicate that descriptions of the matter of the universe reside in primary mechanistic qualities (atoms, molecules, electrons, etc.) which are inferred from the observable secondary mechanistic qualities.

A contextualist world hypothesis is projected in the second analyzed paragraph (lines 25-31) because of the attitude taken toward diagrams and models. This short paragraph needs to be read in its entirety but it is illuminating to analyze each statement separately. "No one knows what an atom or an electron looks like" (line 25) is consistent with the mechanistic treatment projected in the previous statements of this section. That is, the descriptive reality of matter in the universe lies in the interactions of unobservable particles. The next statement claims that diagrams of atoms are "unreal" (lines 26-27). This statement projects a contextualist world hypothesis in the sense that schemes (maps, diagrams, formulas, etc.) make no claim to reality but are instruments useful for predicting, controlling, and explaining. The next statement (lines 27-31) supports this analysis by stating that even though the diagrams make no claim to reality, they are useful for explanation ("enable us to discuss simple chemical reactions").

This illustrative discussion of the analysis of a section permits several points to be emphasized. First, it should be clear that this section could have been split into two. Had that been done, a general statement could be made that the first section tends to project mechanism, while the second projects contextualism. The analysis itself would not be changed.

Second, in this section there are a number of substantive units which might correspond to certain characteristics of a world hypothesis, but are not analyzed. For example, the statement that "the chemical properties of these elements are dependent on the structure of the atoms that form their smallest parts" is not analyzed, even though it clearly projects mechanism because of the assumption that observable phenomena can be explained by reducing them to interactions among inferred particles. To analyze that statement would have added nothing to the judgment about projected world hypotheses and nothing to the demonstration of the use of the scheme. Throughout the analysis, then, only a few of the "analyzable" substantive units are treated in any given section.

The analysis of this section exemplifies the holistic attitude taken in the entire analysis. The first paragraph, as a whole, intuitively projects mechanism. The second paragraph, as a whole, intuitively projects contextualism. To reduce or limit the analysis to smaller parts without respecting the context provided by these two paragraphs would be to produce a shallow analysis. But, at the same time, it is not necesssary to analyze every grammatical unit or unit of meaning to notice a qualitative trend. And, the fact that claims of projection are about the substantive units of analysis makes problems about a unit of analysis less serious.

Notes in Advance of Reading the Analysis

Here the reader is prepared for detailed examination of the analysis itself. The investigator's procedure in performing the analysis is delineated in light of considerations dealt with in the first two parts of this chapter, and information is provided about the way the analysis is presented.

The investigator's procedure

The investigator's approach to this analysis was guided, of course, by his experience with the preliminary analysis, which suggested that a first step is to read the material in its entirety to get a "feeling" for it and thus be able to retrieve relevant context from notes for detailed work later. During that first reading, the investigator made note of sections of the textbook which seemed, intuitively, to project particular world hypotheses. No attempt was made at that point to construct an argument to substantiate the intuitive feeling, in order to deviate as little as possible from the intent to obtain a holistic impression of Speed's textbook.

The analysis proper was begun by re-examining each chapter of the textbook. From earlier notes, a sketch was made of the sections to be established and analyzed. At this point, all material in the textbook was considered appropriate for analysis, but of course it was both impracticable and unnecessary to do so.

Selection of material

Two principles guided the final selection of material to be analyzed. Speed's General Biology consists of seven major units containing 33 chapters--a total of 440 pages. The first selection principle: be certain that some material is analyzed from every unit (not necessarily every chapter), in order to ensure that substantive issues in the discipline of biology treated by the textbook are represented in the analysis. (Units in the textbook are organized in that fashion, as can be seen in its Table of Contents, reproduced as pages A161-A168.)

From the detailed second reading of each chapter, it became clear that it would be extremely repetitive to analyze and present here every section dealing with substantive issues in biology as selected in accordance with the first principle stated above. Thus the second principle: after several sections are analyzed in a given chapter the analysis is terminated if no new or interesting information _about the use of the scheme_ is emerging. (It must be recalled that the purpose of this analysis is _demonstrative_, and the information sought is guided by the three questions stated earlier in this chapter.)

Relevant context was considered in the analysis of sections, as noted above. The detailed analysis of a section involved finding substantive units that corresponded to characteristics of a world hypothesis. It was at this point in the analysis that the investigator undertook to substantiate his earlier intuitions about projection of world hypotheses. If the intuition could not be substantiated, no claim about projection was made, and another section was chosen.

Approximately 100 sections have been analyzed, and of these approximately 50 per cent are subtopics from Speed's textbook (usually several paragraphs), 35 per cent are paragraphs, and 15 per cent are of miscellaneous length (e.g., several sentences were analyzed as sections, and two chapters were analyzed each as a section). In all, roughly one third of Speed's textbook is reproduced as Appendix V (some 150 pages). These pages contain the actual sections analyzed, of course, and in addition some are included to provide context.

Emerging concerns about mechanism

During the analysis, the investigator became increasingly concerned about two issues having to do with the claim that a mechanistic world hypothesis is projected by a substantive unit of analysis. These issues are of sufficient importance to warrant comments for the reader at this point about the investigator's procedure for dealing with them.

Pepper's treatment of the mechanistic world hypothesis shows the development of discrete mechanism and consolidated mechanism, and both of these varieties are included in the investigator's analytical scheme. According to Pepper, the categories of discrete mechanism ultimately lead to consolidated mechanism in which "discrete" particulars are "consolidated" into the spatiotemporal-gravitational-electromagnetic field. "The chief modern impetus for consolidation comes, of course, from relativity theory, for this has to do with the details of the spatiotemporal field."[1] In effect, then, Pepper has shown that mechanistic categories can account for recent developments in physics.

Discrete mechanism.--However, for purposes of this study a claim for the projection of mechanism refers to *discrete* mechanism, unless specified to the contrary. The rationale for this is twofold. First, the categories of consolidated mechanism lend themselves to interpretation in terms of contextualism and, therefore, it is difficult to make a distinction (at least in non-philosophical material) between the two. Second, common usage of the term "mechanism" (e.g., in the quotations from Laszlo, and in Bertalanffy's "physicalistic world picture"--Chapter III, pp. 90-93) is more consistent with Pepper's discrete mechanism. Also, the investigator's arguments in Chapter II concerning the limitations of mechanism, which speak for the significance of this study, deal with mechanism in its discrete sense.

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[1] Pepper, *World Hypotheses*, p. 213.

Cultural context.--Context provided by the discussion in Chapter III also affects one's analysis with regard to a mechanistic world hypothesis. Pepper points out in the discussion of the mechanistic root metaphor that "action-by-contact," "quantification," and "location of parts" are hallmarks of discrete mechanism.[1] Thus when these characteristics are seen, a claim is made for the projection of mechanism. The justification for making such a claim lies partly in the fact that these characteristics are logically primitive in mechanism. (The convention for dealing with logically primitive characteristics has been discussed earlier in this chapter.)

Cultural context provides further justification for claiming that mechanism is projected when any of the characteristics of action-by-contact, quantification, and location of parts are detected. If the analyses of Roszak, Laszlo, and Bertalanffy (among others) are correct, it seems that North American society's sense of reality tends to be a mechanistic one. Notwithstanding the vagueness of the common use of "mechanism," there is some justification provided by cultural context for the idea that sections specifying concepts of action-by-contact, quantification, or location of parts have greater *potential* for being understood mechanistically than by any other world hypothesis.

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[1] Ibid., pp. 187-191.

Presentation of the analysis

The analysis is presented in Appendix IV. For the reader's convenient reference, the six-part analytical scheme is located in Appendix III and the pertinent pages of Speed's textbook are reproduced in Appendix V.

Reading the analysis

The sections analyzed are coded in the following way. For instance, in the code number 17L1-R13, *17* refers to *page 17* of Speed's textbook, *L* refers to the *left column* on the page, *1* refers to *line 1*, *R* refers to the *right column* on the page, and *13* refers to *line 13*. Thus the code number 35L1-37L54 is read: page 35, left column, line 1 to page 37, left column, line 54. These code numbers refer to the sections analyzed. An entire section in Speed's textbook should be read before reading its analysis. Also, the analyses should be read in sequence, since parts of the later analyses assume discussions developed in the analysis of previous sections.

Some comments on terminology

As noted earlier, the word *section* is used to refer to any portion of material analyzed, regardless of its length (chapter, paragraph[s], sentence[s], phrase[s]). In addition to the generic term *section*, and the common-sense terms *chapter*, *paragraph*, *sentence*, *phrase*, two terms with specialized meaning will be used in referring to sequences of written material. The term *statement* is used to refer to the meaning content of written material. A statement could be embedded within a sentence, it could coincide *with* the sentence, or it could be one or more sentences. The term *string* is more general, and is used to refer to sequences of written material which may or may not be "well formed" in terms of meaning content.[1]

Structure of section analyses

In many cases, the analysis of a section is written in three parts. The "overview" consists of general comments about the section, noting its idiosyncratic features, for instance. In the "overview" mention is sometimes made of relevant context for the section, or there may be a reference to the analysis of a previous section. In the second part, "analysis," substantive units of analysis are identified and shown to project world hypotheses. The third part, "comments," consists of reflections on the analysis and makes points about the application of the scheme or unique problems with the claim of projection. (The comments from each section analysis provide most of the material for Chapter VI of this study, in which observations are made about the use of the scheme.) This three-part structure is used only where necessary, and for many of the sections the three parts are collapsed, or one or two parts are missing.

At this point the reader is encouraged to turn attention to the analysis presented in Appendix IV. Commentary about the findings of the analysis is reserved for Chapter VI. The remainder of the present chapter is devoted to a critique of Pepper's treatment of world hypotheses, which will be more easily understood once the reader has completed examination of the analysis.

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[1] These terminological distinctions are from E. Brent, personal communication.

Critique of "World Hypotheses"

Qualifications, conditions, and some limitations surrounding the demonstrative application of the analytical scheme developed in this study have been discussed in the first three parts of this chapter. Now that the reader has had an opportunity to examine the analysis itself, those qualifications, [illegible]tions, and limitations are probably more meaningful.

Here the investigator wishes to examine another kind of limitation--that of Pepper's world hypotheses themselves. Philosophical criticism of Pepper's position is reviewed, and limitations of his approach are noted. The investigator's purpose is to show how those limitations affect the application of the analytical scheme to one textbook in this exploratory study, and to curriculum issues in general.

This portion of the chapter has three sections. The first briefly reviews Hoekstra's criticism of Pepper's notions of "adequacy" and "evidence." In the second section, the present investigator embellishes Hoekstra's criticism by challenging Pepper's grounds for claiming that animism and mysticism are inadequate world hypotheses. Finally, there is a challenge to Pepper's position that the world hypotheses are autonomous, and that the categories of each world hypothesis "hang together" to form coherent positions. This latter criticism has the most effect on the present study.

Hoekstra's Criticism

Pepper treats six world hypotheses in detail: animism, mysticism, formism, mechanism, contextualism, and organicism. The first two he considers inadequate in their ability to give a systematic account of phenomena; the last four he considers to be equally adequate.

> Out of the seven or eight basic world hypotheses, so derived from their root metaphors, four are to such a degree superior to the others in adequacy that they alone need be seriously considered. These also may some day be superseded, but the present situation, we believe, is one in which these four must be given equal or nearly equal weight in any cognitive judgment or evaluation where we want all the evidence we can get on a matter.[1]

Hoekstra calls this position "metaphysical toleration" and points out that, if this program were realized,

> philosophers would cease to be utter skeptics and would not repudiate all metaphysical systems. Yet they would refrain from accepting only one system and rejecting all others. That is, they would cease to be dogmatists. For a claim to certainty is dogmatism to Pepper. Philosophers would regard all systems as dubitable, but would look favorably upon rival theories even if they were irreconcilable, provided they were found to be equally adequate. . . . The entire book aims to prove that the only possible rational outlook in metaphysics is the recognition of four alternative and exclusive world hypotheses, all equally adequate, among which no rational choice is possible. Once this equality is recognized, philosophers would admit the futility of most metaphysical controversy and "the big four" of philosophy--formism, mechanism, contextualism, and organicism--would settle down to mutual cooperation with a limited autonomy provided for each.[2]

Hoekstra points out that metaphysical toleration is justified only if the four world hypotheses can be shown to be equally adequate.

> Pepper's liberal attitude in metaphysics is based upon a reasoned belief in the equality and autonomy of four world hypotheses. If

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[1] Pepper, World Hypotheses, p. 329.

[2] Raymond Hoekstra, "Pepper's World Hypotheses," The Journal of Philosophy, XLII (February 15, 1945), p. 85.

> he can not rationally demonstrate these premises, then the attitude of toleration does not necessarily follow. For clearly Mr. Pepper does not advocate toleration toward every metaphysical hypothesis but only toward those which are equally adequate. If, therefore, a system is inadequate or less adequate than another, it is not intellectually tolerated. Toleration toward any system demands rational adequacy of that system, and, if I understand the argument correctly, only the most adequate systems should be permitted.[1]

The brunt of Hoekstra's criticism falls on Pepper's argument for the acceptance of the four world hypotheses--the argument that they are equally adequate.

> Since Pepper claims to offer such an argument, I propose to examine its soundness. I wish first to discuss the rational tests for adequacy for world hypotheses which Pepper advances. Then I shall study the relation of Pepper's exposition of the nature of evidence and hypothesis to the four major world hypotheses.[2]

Adequacy

Hoekstra's criticism of Pepper's claim of equal adequacy rests on the argument that the four world hypotheses cannot all be adequate in the same sense of the term, since each has its own criterion of adequacy. Hoekstra's argument begins with Pepper's meaning of adequacy.

> "Adequacy means nothing but degree of structural corroboration, and for the details of what this means there is no authority but the actual world theories which have achieved such corroboration." There is no universal sense in which the four systems are true, because each system has its own categorial interpretation of truth. But adequacy is a property exhibited by various systems of philosophy and connotes degree of structural corroboration, which in Pepper's usage means the corroboration obtained by the support of one fact by another. Now, clearly, since the detailed nature of what is meant by structural corroboration will vary in each of the four adequate types, it follows that the four systems can not unequivocally be said to be adequate. Each system could be said to be adequate in its own sense of that term. But all the four systems could not be said to be adequate in the same sense of that term.[3]

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[1] *Ibid.*, p. 86. [2] *Ibid.*, p. 88. [3] *Ibid.*

Before examining the effect of the argument on the present study, it is helpful to review Pepper's reply to this criticism. Pepper explains that lying at the base of Hoekstra's criticism "is the attitude of expecting an unquestionable criterion of truth and factuality to be at hand."[1] And, of course, Pepper questions the defensibility of that attitude.

> "Adequacy" means the amount of corroboration an hypothesis gets in its handling of its evidence. But Professor Hoekstra wants me to identify adequacy with some definite principle more determinate than just mentioned. This is where the traditional attitude comes in demanding an external criterion to determine definitely what is or is not good cognitive material. Since the nearest thing to this traditional idea in World Hypotheses is any one of the refined cognitive criteria of the four relatively adequate world hypotheses, Professor Hoekstra insists that I apply one of these, and accuses me of ambiguity in the conception of adequacy because I have four such criteria instead of one. . . .
>
> The sense of adequacy that consistently applies throughout my treatment is that of an hypothesis covering its relevant evidence with precision--a well recognized sense of the term. Now, one of the central problems of cognition is to find out precisely what "adequacy" in the above sense means. There are many hypotheses on this matter. In the narrowest sense these are hypotheses about the nature of truth, but in the fullest sense there are the world hypotheses themselves. I have sought to show that there are four hypotheses about the precise nature of adequacy which are more adequate than any others in terms of the scope and precision of evidence they enfold, but that none of these four is sufficiently superior to the others in terms of adequacy in the general sense to warrant our identifying the precise nature of adequacy even tentatively with any one of them. . . .
>
> As I said earlier, what I fear Professor Hoekstra wants is something he can not empirically have with the evidence on hand--namely, the completely adequate determination of adequacy.[2]

The effect of Hoekstra's criticism on this study will now be examined. To this point in his criticism Hoekstra deals solely with the relative adequacy of Pepper's world hypotheses. Even if his criticism is valid, however, it does not affect the exploratory examination of teaching materials to detect world hypotheses projected to student readers. The identification and use of characteristics of world hypotheses is not affected by, nor has it any bearing on, the adequacy of those world hypotheses. For example, the use of the root metaphor of mechanism to detect an implied mechanistic position has nothing to do with the adequacy of the position in accounting for phenomena. Nevertheless, even though the present study is not affected by Hoekstra's criticism, curriculum prescriptions could be affected by that criticism. This issue will be taken up shortly through a discussion of Pepper's charge that the world hypotheses of animism and mysticism are inadequate.

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[1] Stephen C. Pepper, "Reply to Professor Hoekstra," The Journal of Philosophy, XLII (February 15, 1945), p. 101.

[2] Ibid., pp. 103-104.

Evidence

We now turn to Hoekstra's criticism of Pepper's concept of evidence. His point is that Pepper implicitly holds an eclectic concept of evidence while his root-metaphor theory explicitly denies the defensibility of such eclecticism.

> I shall enumerate without discussion some of the eclectic features of his theory of evidence:
>
> 1. The social character of multiplicative corroboration as a way of refining data is derived from pragmatism.
> 2. The repetition of similar experiences required by multiplicative corroboration implies the root metaphor of formism.
> 3. The emphasis on synthesis and system present in all structural corroboration is reminiscent of the coherence theory of absolute idealism.
> 4. The rejection of any knowledge of pure fact and the insistence that every known fact is already infected by categorial interpretation is lifted from Kant's Critique of Pure Reason. Kant's argument for the existence of noumena is similar to Pepper's belief that if there are

> pure facts they can not be known. For Kant there was, of course, but one absolute set of categories which was both universal and necessary, while for Pepper there may be alternative sets of categories, each of which is universal but not necessary.
>
> 5. The treatment of categorial sets as postulates for a system and the belief in alternative logics with one logic to each system is characteristic of the postulational technique of mathematical logic and thus rests upon formistic sources, recently supported by pragmatic conventionalism.
>
> 6. The unsatisfactory character of common sense as the necessary but unreliable source of all knowledge is in my own intellectual biography associated with the approaches of critical realism and absolute idealism. These epistemologies invariably began with an attack upon the assumption of the common-sense man.
>
> If I am right in the above attributions, then Pepper's method and critical emphases are eclectic. The root-metaphor theory of world hypotheses entails the rejection of eclecticism. I therefore find a fundamental opposition in the book between the root-metaphor theory and the theory about evidence and hypothesis. The theory of evidence involves eclecticism. The root-metaphor theory opposes it. The two theories are thus incompatible.[1]

Again, if Hoekstra's criticism is valid it does not affect the present study. An inconsistency between Pepper's concept of evidence and his root-metaphor theory does not preclude the use of characteristics of world hypotheses to detect their projection in teaching materials. But, it is possible that Hoekstra's critique of the concept of evidence could affect curriculum prescriptions. We now turn to this issue.

Adequacy and evidence: animism and mysticism

It will be shown that some curriculum prescriptions, arising out of the analysis of social issues in terms of world views, are affected by Hoekstra's critique. If Pepper's claims about adequacy do not hold, then these prescriptions do not hold. This will be shown by example through an embellishment of Hoekstra's criticism. In so doing, the investigator will criticize Pepper's claim that the world hypotheses of animism and mysticism are inadequate. An outline of the argument follows.

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[1] Hoekstra, "Pepper's World Hypotheses," p. 100.

1. By Maxim II (autonomy of world hypotheses; see Appendix I, p. A9), the claims of one world hypothesis cannot be legitimately scrutinized with the categorial assumptions of another world hypothesis.
2. Pepper claims that the world hypotheses of animism and mysticism are inadequate. The basis for this claim ultimately rests on the contention that animism and mysticism ignore factual evidence.
3. But, while some concept of evidence is implicit in the categories of formism, mechanism, contextualism, and organicism, no concept of evidence is recognized by the categories of animism and mysticism. The accusation of ignoring evidence carries no weight in animism and mysticism.
4. Therefore, Pepper must violate Maxim II in order to substantiate his claim that animism and mysticism are inadequate, since he must use a categorial assumption of the other four world hypotheses to criticize animism and mysticism.
5. Consequently, a curriculum prescription such as "We should not teach or condone animism and mysticism in the classroom because they are inadequate world hypotheses" can be questioned if its justification depends on the inadequacy of these two world hypotheses.

Curriculum prescriptions

It will be convenient to begin with the fifth point and then proceed with the rest of the argument. It has been made clear that criticism of Pepper's claims about adequacy and evidence has no effect on this particular study. However, closely related curriculum issues are affected by this criticism. These can be conceived in terms of curriculum prescriptions which, apart from value positions, are based on knowledge about world views and social issues. For example, there are implications for curriculum prescription in Roszak's anti-mechanistic pro-mystical stance.

Such curriculum prescriptions might take this form: Since world hypothesis X is more adequate than Y, X should be taught explicitly and condoned in schools. Or: Since world hypothesis Y is inadequate compared to X, Y should not be taught or condoned in schools. In fact in most public schools in North America the latter prescription can be more precisely expressed (it is tacitly held, of course) as this: Since animism and mysticism are inadequate world hypotheses, they should not be taught or condoned in schools.

This prescription will now be used as an example. Given Pepper's argument of the inadequacy of mysticism and animism as world hypotheses, and given the value position that no inadequate world hypothesis should be taught, the prescription is justified. On the other hand, if this argument of Pepper's is not valid, then the prescription can not be justified, or must be justified on other grounds. The lack of rigorous justification for this prescription is important, for example, in the light of Roszak's analysis, which can be seen to suggest that mystical and animistic world hypotheses might be useful ways of coping with experience.

Pepper's argument

Hoekstra attacks the notion that four world hypotheses could be equally adequate in the same sense of that term by analyzing the criteria Pepper uses to determine adequacy. While Hoekstra's criticism concentrates on challenging the grounds on which four world hypotheses are considered adequate, he does not challenge the grounds for arguing that two world hypotheses are inadequate. The reason that Pepper considers animism and mysticism inadequate will now be examined.

Animism.--According to Pepper the adequacy of world hypotheses is measured by precision and scope. He claims animism is inadequate because it lacks precision. The root metaphor of animism, spirit, is indeterminate as an interpretative principle.

> What is thunder? It is the angry voice of a great spirit. It is the stamping of the hoofs of the steeds of a great spirit. It is a great spirit clanging his arms. It is the roar of the lightning bolts hurled by a great spirit. It may even be a spirit itself roaring in pursuit of some other spirit to devour. These interpretations are all consonant with the categories of spirit, and there is nothing but the limitations of poetic fancy to put a stop to such interpretations. There is no one precise and determinate interpretation of thunder, nor is there any precise method for finding one, nor is there any hope that more factual observation will ever produce one through these categories.[1]

But what does Pepper mean in this instance by precision? Why are these explanations for thunder imprecise? Because, according to Pepper, a number of interpretations are

> consonant with the categories of spirit. . . . There is no one precise and determinate interpretation of thunder.[2]

Pepper assumes that there should be one precise interpretation of thunder--that which conforms to the evidence presented to us by the phenomenon. He says "nor is there any hope that more factual observation will ever produce one through these categories."[1] The phrase "more factual observation" in this statement is symptomatic of Pepper's concept of evidence.

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[1] Pepper, World Hypotheses, p. 122. [2] Ibid.

Later, in his criticism of Tolstoy's animistic account in *What Is Religion?* Pepper comments on Tolstoy's procedure.

> Notice also the two sources of the persuasiveness of his procedure--for there is no question that many are persuaded by this and similar arguments: First, the procedure is such as to depersonalize or sterilize the animistic categories and so make them acceptable to a somehwat critical intelligence, which will entertain concepts ("Infinite Life," "God," "source of all," "particle of this divine element") when it would refuse to entertain the images and concrete evidence to which these concepts refer.[2]

Pepper's use of the term "concrete evidence" indicates clearly that he assumes a concept of evidence in his argument. In effect, then, Pepper criticizes animism because it does not take into account evidence that we have about phenomena.

Mysticism.--Similarly, with mysticism Pepper assumes a concept of evidence in claiming that this world hypothesis has inadequate scope. "Where it [mysticism] does not plausibly succeed, it denounces the unsubmissive 'facts' as unreal; and, since there are many of these, it spreads unreality far and wide."[3]

Critique of Pepper's argument

Pepper's account of the four adequate world hypotheses (formism, mechanism, contextualism, and organicism) shows that each of these world hypotheses implies some concept of evidence--although not necessarily the same concept. (Thus Hoekstra criticizes Pepper's eclectic "theory of evidence.") But that these four world hypotheses imply some concept of evidence is clear. Furthermore, the investigator has argued that the categories of animism and mysticism do not imply a concept of evidence. The epistemologies of formism, mechanism, contextualism, and organicism include the evidence condition, while the epistemologies of animism and mysticism do not.

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[1] *Ibid*. [2] *Ibid*., p. 126. [3] *Ibid*., p. 127.

In arguing for the inadequacy of animism and mysticism, Pepper uses a concept that comes from other world hypotheses. Thus he violates Maxim II which asserts that each world hypothesis is autonomous. His claim that animism and mysticism convict themselves of their inadequacy is not well founded, since the criterion for inadequacy lies in other world hypotheses.

It is important to examine the part of Maxim II that pertains to this case.

> It is illegitimate to disparage the factual interpretations of one world hypothesis in terms of the categories of another--if both hypotheses are equally adequate.[1]

Particularly interesting is the clause "if both hypotheses are equally adequate." This begs the question. Substantively, this is a criticism similar to Hoekstra's. Two systems cannot be said to be inadequate on the basis of criteria for judging the adequacy of four other systems, if each system has its own criterion of adequacy and there are no independent criteria.

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[1] *Ibid.*, p. 98.

Summary

It has been shown that there are grounds for criticizing Pepper's argument that animism and mysticism are inadequate world hypotheses. The criticism does not affect the exploratory analysis of teaching materials in this study, but it does affect curriculum prescriptions which are justified according to the relative adequacy or inadequacy of a world hypothesis. We now turn to an issue which affects this study more directly.

Pepper's inconsistency

This section is a critique of Pepper's framework which does affect the application of the investigator's analytical scheme to teaching materials. It is to be criticized that, on the one hand, Pepper claims the world hypotheses are autonomous and eclecticism is confusing while, on the other hand, he admits that at various points the world hypotheses overlap. Therefore he is inconsistent. Those points at which world hypotheses overlap make it difficult to distinguish the projection of one world hypothesis from the projection of another in the kind of non-philosophical material with which this study is concerned.

According to Pepper the categories of a world hypothesis are consistent within that world hypothesis.

> For a categorial set is nothing more nor less than the structural lines of corroboration for the world theory in question. The categories hang together in sets because they mutually corroborate each other through the evidence they gather up. And different sets of categories draw apart from one another precisely because they fail to corroborate one another.[1]

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[1] Ibid., p. 329.

The way categories "hang together" allows Pepper to claim that world hypotheses are autonomous and that eclecticism is confusing.

> If world hypotheses are autonomous, they are mutually exclusive. A mixture of them, therefore, can only be confusing.[1]

But Pepper is vague on exactly how the categories "hang together" and why some categories of a particular world hypothesis might not as well be found in another world hypothesis. In fact he comments that

> it is not to be denied . . . that the root metaphor of one theory may merge with that of another, and eventually all may come harmoniously together. But this idea itself is a principle derived from one world theory, and cannot be affirmed until, or if, that theory (organicism) should turn out to be completely adequate.[2]

Thus Hoekstra is led to argue that world hypotheses cannot be autonomous.

> Examine the following quotations: "If world hypotheses are autonomous, they are mutually exclusive." "The reason that there are several root-metaphor theories is precisely that they are all fully comprehensive and their categories refuse to merge and their danda refuse to harmonize." Mutual exclusion, refusal to merge and to harmonize--are not these the traits of inconsistency? If so, then Pepper extends the tests of consistency beyond each system to the relations between them. But this is illegitimate. For if the four systems are autonomous, then there are four alternative and exclusive logical canons. And the meaning of inconsistency internal to one of the systems can not be applied to relations between them.
>
> . . . .
>
> In this sense of autonomy it is easy to show that Pepper's favorite systems are not autonomous. Mechanism contains ineradicable aspects of formism, since both systems use the categories of quality and law. By Pepper's own admission, "contextualism and organicism are so nearly allied that they may also be called the same theory, the one with a dispersive, the other with an integrative, plan."[3]

The problem this entails for the present study is that there are some instances in which, because of the overlapping of categories, it is difficult to judge which world hypothesis is projected. The following statement from Speed's text is an example.

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[1] Ibid., p. 104. [2] Ibid., p. 105.

[3] Hoekstra, "Pepper's World Hypotheses," pp. 98-99.

> Living things thus exist in a decaying, physical universe and, like this universe, obey the thermodynamic laws.[1]

In formism, natural laws are seen as forms which nature necessarily follows. This statement projects formism because of the way the term "obey" is used with regard to the thermodynamic laws. But this is not a strong claim because "law" also constitutes a category within mechanism. And Pepper makes the following remarks with regard to Newton's laws of motion and the mechanistic category of "law."

> These laws, it will be seen (exactly these laws for Laplace, these or similar laws for other mechanists) constitute the dynamic element in the mechanistic universe. The field itself is static and undifferentiated. Even when the field is dotted with masses, it still lacks efficacy. The dynamic structure of nature comes from the laws which connect the masses together and guide them from one configuration to another.
>
> Now, there is an important point to notice in the Laplacean conception. He says, Let me know the configuration of masses in the spatial field at any one time, and the laws which operate upon these masses, and I will describe the configuration of the field at any other time past or present. What is the status of these laws? He speaks of them as if they were discrete and separable from the masses in the field, or as if they operated upon the field but were not of it--as if, in a word, they were forms which are repeatedly exemplified in the field.
>
> But this is formism and not mechanism. The status of subsistence is implied. And if we allow this status to appear here in the laws, it will spread into the primary qualities, and eventually into the field itself. For if the laws are conceived as repeating themselves identically over the spatiotemporal field, so will the sizes, shapes, and masses, and so perhaps even the locations. For are not all locations just alike, discretely considered? Thus mechanism dissolves into formism, and all its categories vanish to be reinterpreted in terms of the categories of formism. This, as we have earlier hinted, is the constant threat in the rear of mechanism.[2]

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[1] Speed, General Biology, p. 12.

[2] Pepper, World Hypotheses, p. 210.

There evidently is tenuous ground for distinguishing the projection of mechanism from formism by using the category "law." Implied reality of laws, of course, is a hallmark of formism while mechanism insists that things are real only if they have a time and place. But even the basis for asserting this is not clear in Pepper's exposition. That is, Pepper does not provide the basis for saying that categories are linked to form consistent sets which result in autonomous world hypotheses. The nature of the linkage is not clear. And in some areas the linkages are diffuse enough to permit overlapping categories.

Therefore, overlapping of some categories makes it difficult to distinguish the projection of different world hypotheses when the basis for making such distinctions assumes the autonomy of world hypotheses. The methodological difficulty can be traced to this criticism of Pepper's framework. It constitutes a limitation of the application of the scheme in this study.

Summary

In this chapter the major portion of the study has come to fruition. Qualifications and conditions have been specified for the use of the conceptual framework developed in Chapter II as a scheme for analyzing science teaching materials. The investigator's procedure in performing the analysis has been delineated, and information about presentation of the analysis has been provided, both in order to prepare the reader for detailed examination of the analysis itself.

Limitations of this portion of the study conclude the chapter, having been introduced at a point where they are most meaningful for the reader. These limitations include criticism of Pepper's work itself, and are seen to affect the potential of a conceptual framework based on world hypotheses to deal with curriculum issues in general (Chapter III). In addition, the criticism affects the use of the investigator's conceptual framework as a scheme for analyzing science teaching materials, in ways which have been specified. Nevertheless, it is the firm conviction of this investigator that the effect of such criticism is relatively minor in view of the demonstrable power of Pepper's world hypotheses for dealing with the central problem of this study.

CHAPTER VI

SUMMARY AND IMPLICATIONS

Introduction

This concluding chapter is in three parts. The first part reviews the study, including a brief account of its nature and significance. The second and major portion of this chapter reviews the findings of the analysis and presents reflective commentary on the use of the scheme. The chapter concludes with a discussion of the implications of this study for further research and for practice.

Review of the Study

Nature of the study

The problem dealt with in this study is the lack of conceptual frameworks in science education for assessing potential consequences for students of messages (implicit or explicit) about world view in teaching. The problem is met by developing such a conceptual framework, based on the work of Stephen C. Pepper and using his systematic concept world hypothesis.

The argument of the study has three distinct "steps." First, the conceptual framework is developed in Chapter II in the form of a scheme for analyzing science teaching materials. The framework is used in a second step to demonstrate substantive linkages between current social issues and curriculum concerns (Chapter III). The final step of the argument is a case-study, exploratory application of the scheme to a biology textbook (Chapter V).

The yield of the study, then, consists of the analytical scheme itself, the results of the analysis, and reflective commentary on the use of the scheme.

Significance of the study

Aspects of social criticism constitute a vantage point from which to view the significance of this study. In Chapter III it is suggested that North American society's sense of reality is based on a mechanistic view of the world and that this view is limited if held to be the only perspective for coping with experience. According to some social critics, a mechanistic perspective has been instrumental in the development of social problems of an existential nature--the experience of nothingness, as Novak puts it. An assumption of such criticism is that world views can affect individuals. Assuming that they can, this study is significant in that it explores one way in which world views can be transmitted to the young: through the textbooks they study in science courses.

Reflective Commentary on the Use of the Scheme

This section is in three parts. The first contains general comments about the use of the scheme--comments about issues not necessarily associated with any given world hypothesis. The second part consists of comments specific to particular world hypotheses. The third part discusses three questions which give structure to reflection on the analysis.

1. In what ways are messages about world hypotheses presented to students?

2. Are some world hypotheses associated with underlying issues in the textbook?

3. What difficulties are encountered in applying the scheme?

General comments

This section comments on features of the analysis which are not necessarily associated with any given world hypothesis. The commentary here results from reflection on Comments in Appendix IV and is supported by examples from the analysis.

Context

The problem of context has been discussed in Chapter V with regard to specifying a unit of analysis. To leave the unit of analysis flexible enables the investigator to better accommodate context in the analysis. However, while the use of a flexible unit of analysis gives recognition to context, it does not solve the problem which context presents to this study: its influence on a judgment that a world hypothesis is projected.

There are two aspects to this problem. On the one hand, there is the problem of specifying criteria for determining what can and cannot reasonably be regarded as context. On the other hand, there is the problem of determining what context is relevant to a particular judgment and, further, to what extent relevant context should influence a judgment.

A full treatment of these complex issues is beyond the scope of this exploratory study and, consequently, problems of context are noted but not solved. This is regarded as a limitation of the application of the scheme. However, some potentially useful information concerning context has been obtained during the analysis and is now reported.

Context within the textbook.--A distinction must be made between context as written material within the textbook and outside the textbook. For the most part, when making a judgment of projection this study is concerned with the former. For example, in section 167R1-169L26 the development of excretory systems is discussed and the point is made that a simple diffusion gradient can account for excretion in some primitive organisms, while more complex active transport mechanisms and systems account for excretion in higher organisms. In the analysis, a mechanistic world hypothesis is judged to be projected by the sections which account for excretion in terms of simple diffusion. Context relevant to such a judgment is contained in an earlier discussion on diffusion, dialysis, and osmosis in the textbook. Examination of this earlier discussion shows the assumption of mechanistic categories. It is clearly relevant context for the judgment that accounting for excretion in terms of diffusion projects a mechanistic world hypothesis. Here, then, is a case where relevant context is easily specified.

In the same section (167R1-169L26) is an example of relevant context within the textbook, but context less easily specified. It is judged that an organicist world hypothesis is projected by statements which account for excretion in higher organisms in terms of active transport and systems. In part, this judgment is influenced by the "simple-to-complex" treatment common in a preceding portion of the textbook. As organisms become more complex, the implied integration of systems becomes more prominent in explanations concerning those organisms. Thus a "flavor" develops throughout the entire textbook. It is not easily specified, yet clearly it is context relevant to the judgment.

Cultural context.--There are cases in which context outside the textbook is influential in a judgment of projection. One example of this occurs in section 11L1-12L36. In part of the analysis of this section, mechanism is judged to be projected because an account of the occurrence of life (11L1-11) is in terms of inferred particles. Conceptually, these inferred particles lie within the primary categories of mechanism.

In the comments about the analysis of this section, it is noted that mechanism is not the only world hypothesis in which discrete, inferred particles have a role in causal explanation. Cultural context influenced the judgment as follows. According to Bertalanffy, Roszak, and others, Western culture's sense of reality is to a large extent derived from a mechanistic framework. Consequently, it is reasonable to predict that an account of the occurence of life in terms of molecules would be interpreted mechanistically by a member of Western culture. This unstated cultural context lends support to a judgment of projection and is particularly relevant to judgments of the projection of discrete mechanism.[1]

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[1] In this example the judgment is also influenced by the fact that action-by-contact is a logically primitive characteristic of mechanism.

Historical context.--A further example of external context is section 22L9-R9. It is claimed that random collisions between various complex molecules could have given rise to living cells. The judgment is that this discussion projects mechanism in spite of the fact that chance and randomness are consistent with a contextualist world hypothesis, which denies absolute structures or inherent order in the universe. The apparent peculiarity of this judgment has a resolution in the historical context of disputes about the origin of life. Historically those disputes are between mechanists (not contextualists) and vitalists (or special creationists). The judgment that random collision and chance project mechanism rather than contextualism is influenced and supported by this historical context. To judge otherwise would be to ignore important issues in the history of biology.

The reader's focus.--As pointed out earlier, it is problematic to determine the extent to which relevant context should influence a judgment of projection. The reader's "focus" bears on this problem. What is and what is not considered relevant context for a judgment can depend on what the reader focuses on. For example, in section 121R1-122L45 the process of internal and external respiration is discussed and it is judged that both mechanism and organicism are projected. If a reader focuses on those aspects of the account which deal with the transport of oxygen molecules and molecular reactions within the cell, then the judgment may tend toward mechanism. However, one is more inclined to suggest the projection of organicism if the focus is upon integration of organs and systems to carry out a function necessary to life. In the one case, the context relevant to the judgment of mechanism consists of preceding sections and statements in which functions of organisms are explained within a mechanistic framework. In the other case, relevant context is the prior projection of organicism.

There is a further point to be gleaned from this discussion. In situations where a reader assimilates the projection of a particular world hypothesis, he may develop a propensity to interpret other passages single-mindedly. A perspective develops in the reader (or is presented to the reader) and further instances of projection corroborate and help develop the perspective. The process is cumulative and all sections which project the perspective serve as contextual support for the judgment that any one section projects the perspective. A network of support is formed.[1]

Shift of focus in the textbook.--Sometimes, it is difficult to detect shifts of focus in the textbook. A good example of this occurs in section 63L6-R25 on active transport. Prior to this section is a discussion of diffusion, dialysis, and osmosis, all of which can easily be accounted for within a mechanistic framework. Of course, active transport can be accounted for within a mechanistic framework, but nevertheless there seems to be a quality to section 63L6-R25 which indicates a slight shift in focus toward an organicist perspective. This quality is seen in part because of the implication of an integrated system within a membrane for carrying out active transport, and because the membrane as a whole is considered the viable unit. Therefore, while the judgment that organicism is projected is not a strong one, it does reflect a shift in focus.

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[1] Considerations about how student readers actually interpret written material are beyond the scope of this study, as noted earlier. Nevertheless, the points made here have emerged from the investigator's own experience with the analysis and therefore are reported as part of the problem of context.

Multiple projection

There is ample evidence from the analysis that this biology textbook projects several world hypotheses, rather than a single one. One clear example is the overwhelming projection of mechanism in Chapter 2 ("The Organization of Molecules") and the clear projection of formism and contextualism in Chapter 26 ("Classification of Organisms"). In this example the projection of different world hypotheses corresponds to two different issues.

In some cases, however, alternative world hypotheses are projected even though related issues are being discussed. For example in section 48L1-R23 cellular aggregation is discussed and it is judged to project organicism. Later, in section 58L15-16, the statement is made that "cellular control is essentially molecular control," which projects mechanism. Different world hypotheses are projected even though cell aggregation and cell control both pertain to the functions of the cell.

Relevant and incidental projection

The kind of projection with which this study is primarily concerned can be called relevant projection to denote that it develops from (or is associated with) issues in the description and explanation of biological phenomena. There is, however, incidental projection which occasionally occurs in the analysis. It is incidental in that it develops from pedagogical devices (metaphors, analogies, examples, comparisons, etc.) employed to help the student understand a point being made. For example, in section 21R17-26 the possible variation in proteins from combinations of 20 amino acids is compared to the possible combination of 26 letters to form words. Here the use of quantification in the comparison is judged to project mechanism.

And in section 386R1-387L20 a rather lengthy and detailed estimation of the number of electrons in the visible universe is given to help the student understand the possible gene combinations in humans. The extensive use of quantification to make the estimation is judged to project mechanism. In both of these examples the potential message to the student is: something is more easily understood if its description or explanation is quantified.

Non-projection and anti-projection

There are a number of sections in the textbook which reveal no information with regard to projection of world hypotheses. And there are cases where one hypothesis might be projected, but none of the others is clearly projected. Non-projection is a term that can be used to characterize a case where no judgment about projection can be made.

In at least one case, however, there is the implication that a world hypothesis is not an adequate way of viewing reality, and anti-projection is a term that can be used to characterize this situation. In section 35L1-37L54 a brief historical account of cell theory points out that better understanding of the cell was due to the improvement of microscopy. Anti-projection of animism occurs in the claim that

> unfortunately, Swammerdam became convinced that his studies of these hitherto invisible forms of life were uncovering the secrets of life known only to the Creator and he burned all his sketches and destroyed his microscopes.[1]

Assuming that the use of the word "Creator" implies some form of animism, the use of "unfortunately" in the context of the rest of the discussion suggests that an animistic world hypothesis is not an appropriate way to explain phenomena.

Ambiguous terms

Sometimes a judgment is made on the basis of ambiguous terms in the textbook and in such cases it is regarded as tenuous. For example, in sections 187L1-17 and 198R10-27 the concepts of "will-power" and "conscious desire" are judged to preclude the projection of the deterministic world hypotheses of mechanism and organicism. Yet this judgment is tenuous since "will-power" and "conscious desire" are ambiguous.

Organization of material

Before concluding these general comments on the application of the scheme, it is helpful to consider that the way in which material is organized in a textbook (unit, chapter, etc.) provides a context in which to make judgments about projection. Generally speaking, this textbook moves from molecule to ecosystem in its treatment of biology. Description of the physical universe precedes discussion of the biological universe and one might well infer that knowledge of the former is a prerequisite to knowledge of the latter. Discussion of the physical universe in Unit I fairly consistently projects mechanism, and this *could* provide a context for making judgments concerning biological phenomena later in the text.

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[1] Speed, General Biology, p. 35.

Making judgments about each world hypothesis

Here features of the analysis are discussed that are specifically related to Pepper's concept of world hypotheses and to particular world hypotheses. Again, the commentary is a result of reflection on the analysis. Before preceeding to a discussion of individual world hypotheses and their application it is worthwhile to note that, generally speaking, the root metaphors themselves remain the most powerful aspect of the scheme for detecting world hypotheses. This is not surprising since the categories are implicit in the root metaphors. This does not mean that an explication of the categories is superfluous for the scheme, but it does show that, once the categories are understood (and their development from the root metaphors is understood), the root metaphors themselves constitute a powerful analytical tool.

The root metaphor of formism, *similarity*, proved to be the easiest to use in the analysis. Judgments could be made without recourse to the relationships among the categories and subcategories of formism. The root metaphor of mechanism was nearly as powerful, but in most circumstances it was necessary to use specific categories. With contextualism it was always necessary to use the categories in order to make a judgment. And, while the root metaphor of organicism (*integration*) was often used in the analysis, because of its vagueness judgments based on it seem inherently weaker. This appears to be an inadequacy of the organicist world hypothesis itself and will be discussed shortly. It is now time to turn to comments which are specific to each world hypothesis.

Animism and mysticism

There are no cases in which it is judged that animism or mysticism is projected. In one section (35L1-37L54) a judgment of "anti-projection" of animism is made, as discussed earlier in this chapter. However, a comment can be made with regard to the projection of animism. Pepper notes that

> animism is the natural metaphysical support of authoritarianism, which inevitably culminates in the dogma of infallible authority. It is ultimately infallible authority that is appealed to for rendering final and determinate the factual interpretation of the animistic world hypothesis.[1]

Furthermore, it has been argued that a concept of evidence is lacking in the animistic world hypothesis, which is consistent with a doctrine of infallible authority. It is interesting to speculate, then, the extent to which animism is projected whenever evidence is lacking in the text for knowledge claims. The following claim provides an example.

> Carbohydrates and fats serve chiefly as energy-giving compounds within the cell.[2]

There is no evidence given in the text to support this claim. For a student the credibility of this claim might conceivably lie with the authority of the author, the teacher, or science, and such authority could be understood in an animistic sense.

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[1] Pepper, World Hypotheses, p. 123.

[2] Speed, General Biology, p. 21.

Formism

Similarity and generalization.--The root metaphor of formism, similarity, has been used often for judging the projection of this world hypothesis. Many statements in the text are generalizations about characteristics of living things and depend on the concept of similarity for their basis. For example, this is a typical statement: "all cells exhibit the following life processes: . . ."(56R13-14). Such a generalization depends on the observation of similar attributes in cells.

Thus it is noticed that the introductory statements of chapters can project formism because of the effort to show that common or similar features of organisms are to be discussed. For example, in Chapter 8 ("Reproduction and Development") the first statement in the introduction is that "most animals, including man, start life as a speck of matter almost too small to be seen with the naked eye" (79L1-29). Formism is projected in this statement because a concept of similarity is necessary to make the generalization.

In fact, formism is projected any time comparisons among organisms are made as in section 149L1-14 ("The Development of Digestive Systems"). In the comment about that section it is noted that in most aspects of the descriptions of organisms there is an assumption of the similar/dissimilar distinction. In the treatment of cell physiology (56R13-14), for example, the discussion is in the framework of a generalization about cell physiology in more than a single cell and in more than one organism. The mere fact that a generalization is made, then, depends on the root metaphor of formism.

Immanent and transcendent formism.--Pepper makes a distinction between immanent and transcendent formism. In transcendent formism, natural objects are observed to grow according to the same plan, and much of the projection of formism in the text develops from this observation. The following statement in 243R24-27 provides an example. "The development of the angiosperm plant resembles in some respects the development of the embryo of triploblastic animals."

A major characteristic of immanent formism is that similar events or objects are described and the results of the description are accepted literally. A good example of the literal acceptance of the results of a description (with no attempt at explanation) occurs in section 233L6-R14 with this statement: "The corn plant has separate male, or staminate, flowers and female, or pistillate, flowers on the same stem."

Natural laws.--One final comment concludes the discussion of formism. In formism, natural laws are norms which regulate the occurrences of nature. The aim of science, therefore, is to discover laws which nature follows. Thus formism is judged to be projected when this attitude toward natural laws is implied, as in the following statement (12L14-16): "living things thus exist in a decaying physical universe and, like this universe, obey the thermodynamic laws."

Mechanism

Action-by-contact.--Mechanism tends to be projected whenever a causal explanation is sought. One of the more obvious characteristics of this world hypothesis is the assumption of an action-by-contact paradigm, and causality is frequently asserted in terms of action-by-contact.

For example, action-by-contact is assumed in section 5L3-15 with the description of the mimosa plant.

> The sensitive mimosa will fold its leaves a second or two after they have been touched by an object. . . . (This reaction is achieved by a change in the water pressure within cells.)

A further example is the explanation of limb movement in terms of levers in section 114L15-R30.

However, the assumption of action-by-contact is not limited to gross anatomical movements. Most explanations, even at the molecular level, assume that some thing has to be located in such a way as to contact some other thing. This is evident, for example, in the account of the physiology of muscular contraction in section 114R31-117R14.

Reduction.--The tendency to reduce the explanation of observable phenomena to interactions among discrete, inferred particles--usually molecular reactions--is a characteristic of mechanism commonly noted in the analysis. This is evident, for example, in the explanation of muscle contraction in terms of molecules of acetylcholine, ATP, and ADP. The projection of mechanism because of the reduction of observable phenomena to inferred particles is also evident in the statement that "cellular control is essentially molecular control" (48L15-16). All physiological accounts in the textbook tend to project mechanism.

Location of parts.--In mechanism, the location of the parts of a machine is essential to its description. An example of the location of parts is seen in section 114R31-50 on the physiology of muscular contraction. Here the efficient parts have been localized to the nerves and the membrane surrounding muscle fibers. The descriptions of organs of the body project mechanism when there is an effort to locate the various parts of the organ that are essential to its function. A good example of this is the description of kidney function in section 171R12-173R8.

Quantification.--The use of quantification is yet another characteristic of mechanism that is used in the analysis to detect the projection of this world hypothesis. One example of the use of quantification occurs in section 114R13-117R14 with the statement that "in resting muscle, the blood is able to supply sufficient oxygen to . . . produce 38 molecules of ATP furnishing 340,000 calories of energy." And, of course, quantification is common in descriptions which involve the location of parts.

Contextualism

Change.--Contextualism is seldom projected in this textbook but, when it is, two prominent characteristics of this world hypothesis serve to detect its projection. The first characteristic is the assumption of change in the universe. By means of the category of change, contextualism is projected starkly in this statement. "In this world of ours, and in the universe around us, nothing ever stands still or remains changeless" (42L26-28). Change is also assumed, of course, in aspects of the theory of evolution, as exemplified in this claim: "The modern theory of evolution of the various species of organisms is that these organisms are the result of a gradual change in living forms over a period of thousands of millions of years" (369L7-11).

Philosophy of science.--The second characteristic used to detect contextualism is the attitude in that world hypothesis toward theories, laws, and classification schemes. Within a contextualist framework, these are human devices useful for explanation, prediction, and control, but do not give insight into reality. This attitude is seen in a discussion of the lack of agreement among classification schemes in section 279L30-47. "If the student is puzzled by this lack of agreement, he should bear in mind that just as there are no absolute laws of nature, only man-made ones, so there is no absolute system of classification except a man-made one."

With regard to natural laws and classification schemes, it is interesting to note that formism tends to be projected when the discussion is about biological issues. However, when the discussion turns to a philosophical reflection on those laws and schemes, as in section 279L30-47, then contextualism tends to be projected.

Organicism

Root metaphor.--The root metaphor of organicism, integration, is used frequently in the analysis for detecting this world hypothesis. This usually happens when there is the implication of an integration of systems and organs or processes that operate as a whole to perform a function necessary to life. An example of this is seen in section 171R12-173R8 on the function of the kidney. Discussions involving the concept of homeostasis and the process of active transport are judged to project organicism because of the implication of integrated processes necessary to life.

This root metaphor (*integration*) is frequently used because it seems to account for an aspect of biology that is less adequately accounted for using other world hypotheses. Yet, the vague root metaphor of integration does not quite capture the quality which comes through in concepts like homeostasis (even though it captures this quality better than do the other world hypotheses), and recourse to the categories of organicism is of little help. For this reason, as discussed in section 171R12-173R8, it is suggested that this limitation of the scheme might be compensated for by the inclusion of yet another world hypothesis such as the *selectivist* world hypothesis developed much later by Pepper, or by Laszlo's similar *systems view*. This new perspective seems promising for dealing with the issues for which the present scheme appears limited.

Historical accounts.--Historical accounts of research in the textbook tend to project organicism because conflicting theories, dead-ends in research, anomalies, and so on are resolved by new research which accommodates these fragments and shows a more inclusive, coherent explanation. For example, section 117R15-118R11 discusses muscle fatigue and a basic contradiction is observed--muscle contraction occurs even when no oxygen is present. This contradiction is resolved with the idea that reserves of ATP build up in resting muscle. But yet another contradiction is noted when it is discovered that these reserves are expended in a few seconds while vigorous muscle contractions can last much longer than this. A resolution for the apparent contradiction comes with a recognition of the role of phosphocreatine in sustained muscle contraction. Thus, organicism is projected by the way in which the research is reported.

Guiding questions

In Chapter I three questions were posited as useful for reflecting on the analysis. Although the answers to these questions are implicit in the analysis and, for the most part, have already been discussed, it is worthwhile to speak to them here directly.

1. In what ways are messages about world hypotheses presented to students?

Evidence from the analysis shows that world hypotheses are projected to students primarily by implication. Sometimes, especially with the root metaphor of formism, a characteristic of a world hypothesis absolutely must be assumed for the passage to be intelligible.

In no case was a conceptual framework expressed overtly. At no point in the textbook was an effort found that makes the student aware that knowledge claims stem from conceptual perspectives. Nor was any attempt found to make the student aware that there are alternative conceptual perspectives, even though alternative conceptual perspectives are often implicit in the issues discussed. The closest the textbook comes to providing for the student to understand that such meta-issues are legitimate areas of inquiry is in the few comments with regard to the status of natural laws and classification schemes. And even then no effort is apparent which makes the student aware that the author is speaking from a particular perspective. These observations are not unexpected, but they are significant in light of the concept of teaching discussed in Chapter I and the social significance of world hypotheses discussed in Chapter III.

2. Are some world hypotheses associated with underlying issues in the textbook?

The answer to this question is "yes," as is evident from the analysis and from comments already made in this chapter. It will be sufficient to review these findings here. The description of organisms tends to be formistic, since it is usually comparative or else it involves a generalization about a class of organisms. In either case similarity is assumed. Classification tends to project formism for the same reasons. Discussions about the status of natural laws, theories, and classification schemes tend to project contextualism. Causal explanation tends to project mechanism, as do discussions of heredity, genetics, and physiology. Historical accounts of research tend to project organicism. Interestingly the discussion of evolution projects three world hypotheses. The assumption of change projects contextualism. Evolution as a theory which accounts for seemingly disparate phenomena projects organicism. And the search for mechanisms to account for the evolutionary process (again, a matter of causes) projects a mechanistic world hypothesis.

3. What difficulties are encountered in applying the scheme?

These difficulties, of course, reveal the limitations of the application of the scheme, and seem to be confined to three major areas, all of which have been discussed previously. First is the problem presented by the fact that the categories of Pepper's world hypotheses do overlap at points, thereby making it difficult to distinguish among them. This limitation is directly attributable to Pepper's treatment. A second limitation of the scheme is the inherent weakness of the organicist root metaphor for dealing with certain aspects of biology (e.g., homeostasis). A third limitation is that there are no guidelines for ascertaining the degree to which relevant context should influence judgments of projection.

Implications of the Study

Implications of this study for further analytical and empirical research, and for practice, are discussed in this section.

Implications for further research

Some implications for analytical research, already discussed in Chapter III, concern the potential for the conceptual framework developed in this study for analysis of complex relationships among world view, social issues, curriculum concerns, and the way teaching is conceived. For example, clarity would be welcome, for purposes of curriculum deliberation, in social criticism which notes the relationship between world view and existential problems.

Further analytical research of interest would be an examination of teaching according to this conceptual framework. It would be of interest to determine whether world hypotheses can be distinguished in teachers' utterances, especially with a view to examining consistency of teachers' interpretations and explanations with teaching materials presented to students.

While the conceptual framework developed in this study is particularly germane to issues in science education, it would be useful to know if world hypotheses can also be distinguished in teaching materials used in other disciplines, and whether or not the projection varies from discipline to discipline.

Yet another implication for analytical research concerns the relationship between Pepper's treatment of world hypotheses and broader, if less systematic, conceptions of world view (e.g., Campbell's concept of epistemological posture, discussed in Chapter IV). This research could be extended to an examination of a wide range of cultural differences, and might provide a basis for conceptualizing curriculum problems regarding the education of minority groups.

Potentially useful empirical studies further to this research certainly include the broad question of curriculum influence in a student's assimilation of world hypotheses. To this end, an instrument based on semantic differential technique might be promising as a way to characterize a student's world view. Longitudinal studies could then be conducted to check for correlations between student world view and the projection of world hypotheses in teaching and/or teaching materials. (A prior study would have to be mounted to resolve a methodological problem noted in Chapter V: how to quantify the projection of world hypotheses in written material.)

Implications for practice

Implications of this study for practice focus on teaching, on teacher education, and on curriculum development. Central to all these implications is a concept of teaching developed in Chapters I and III. Students must be made aware of the bases for knowledge claims, if it is to be said that teaching is occurring.

An obvious implication for science teaching is that world hypotheses be made explicit. This study provides a practical illustration of Pepper's work by relating it to material which is taught in science classrooms, thereby providing a host of examples which suggest how teaching could make world hypotheses explicit.

Implications for science teacher education flow from implications for teaching. Teachers stand to benefit from an awareness of world hypotheses in the same way as students: as a way to "step outside" the perspective imposed by science, in order to understand a variety of current social issues.

In addition, the analytical scheme developed in this study has potential as a device for supervision of science teachers. Through understanding world hypotheses as they are projected in his teaching, the teacher can become aware of the provision he is making for students to understand the basis for knowledge claims.

The study has obvious implications for curriculum development in science. One direction this could take would be the development of sets of materials which exemplify and make clear for the student the use of particular world hypotheses as they guide inquiry. On a larger scale, world hypotheses could serve as the structural basis for an interdisciplinary approach to curriculum.[1]

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[1] James H. Quina, Jr. has explored this possibility. See his "World Hypotheses: A Basis for a Structural Curriculum," Educational Theory (Summer, 1971), pp. 311-319.

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APPENDIX I

WORLD HYPOTHESES AND THE ROOT-METAPHOR THEORY

As a prelude to discussion of Pepper's six world hypotheses and the subsequent development of the analytical scheme, this overview is presented in two parts. The first is a review of Pepper's argument for entertaining a notion of world hypotheses as metaphysical concepts, and the second is a review of Pepper's root-metaphor theory, a theory to explain the development of separate and autonomous world hypotheses.

World Hypotheses

Pepper describes his conceptualization of world hypotheses as follows.

> Among the variety of objects which we find in the world are hypotheses about the world itself. For the most part these are contained in books such as Plato's _Republic_, Aristotle's _Metaphysics_, Lucretius' _On the Nature of Things_, Descartes's _Meditations_, Spinoza's _Ethics_, Hume's _Treatise_, Kant's three _Critiques_, Dewey's _Experience and Nature_, Whitehead's _Process and Reality_. These books are clearly different in their aim from such as Euclid's _Elements_ or Darwin's _The Origin of Species_.
>
> The two books last named deal with restricted fields of knowledge and can reject facts as not belonging to their field if the facts do not fit properly within the definitions and hypotheses framed for the field. But the other books deal with knowledge in an unrestricted way. These unrestricted products of knowledge I am calling world hypotheses, and the peculiarity of world hypotheses is that they cannot reject anything as irrelevant.
>
> . . . .

> I wish to study world hypotheses as objects existing in the world, to examine them empirically as a zoologist studies species of animals, a psychologist varieties of perception, a mathematician geometrical systems. . . . For we all have and use world hypotheses, just as we have animal bodies, have perceptions, and move within geometrical relations. . . .
>
> World hypotheses are likely to be studied as creeds to be accepted or rejected, or as expressions of highly individual personalities, or as expressions of epochs, or as objects of historical scholarship to be traced to their cultural sources or given their philological interpretations. They are rarely treated as objects in their own character and compared with one another. Yet it is this last sort of study that I wish to make.[1]

He claims that, of the six world hypotheses treated in this study (animism, mysticism, formism, mechanism, contextualism, and organicism), two of them--animism and mysticism--are "inadequate." That claim is not of primary importance for this study, but an explication of its basis is helpful in understanding the way Pepper views world hypotheses.

The criterion for "adequacy" depends in part on the argument that the positions of the utter skeptic and the dogmatist are untenable. Pepper points out that the utter skeptic paradoxically must be dogmatic if he consistently holds his position.

> The position of the utter skeptic is, we find on careful scrutiny, impossible. It amounts to the self-contradictory dogma that the world is certainly doubtful. If this thesis is taken seriously, it is not a skeptical position, but a dogmatic one.[2]

The definition of a dogmatist is "one whose belief exceeds his cognitive grounds for belief."[3] A dogmatic position ultimately produces a contradiction which, Pepper asserts, makes the position unacceptable.

> If a man is called a dogmatist, he is judged so in reference to certain grounds or criteria of belief. Who determines those grounds? The accused himself, or another? It seems incredible that a man could be a dogmatist in the face of cognitive criteria which he himself has acknowledged. It seems unjust that he should

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[1] Pepper, World Hypotheses, pp. 1-2. [2] Ibid., p. 9.

[3] Ibid., p. 11.

> be called a dogmatist in relation to criteria which he has not acknowledged. All dogmatists appear to be relative dogmatists, and who is to judge among the alternative grounds of belief?
>
> The temptation arises to say that all grounds of belief are equally good. But that is precisely the doctrine of utter skepticism. Thus the circle becomes complete. Utter skepticism leads into dogmatism, and dogmatism leads into utter skepticism. For a generalized dogmatism is simply an utter skepticism with the accent changed. If in the one everything is certainly doubtful, in the other everything is doubtfully certain.
>
> The fact is that a dogmatist never will generalize, and that is precisely where his dogmatism has its birth. Among his acknowledged criteria of belief is one which if generalized would lead to his acceptance of beliefs or degrees of belief which he refuses to accept. He explicitly acknowledges cognitive criteria which he implicitly denies.[1]

Pepper rejects claims of infallibility, certainty, self-evidence, and indubitability as ultimately appealing to dogmatism, and concludes that "there is no certain evidence of any kind. . . ."[2]

This leads to the idea that there are two qualitatively different types of evidence. On the one hand there is "common sense evidence," which by nature is relatively unrefined and uncritical. On the other hand there is "critical evidence," which is highly refined and critically sound. The distinction between the two types of evidence is elucidated in Pepper's comment on a sense-data account of a tomato.

> We have . . . a good example of such transmogrification [from common-sense evidence to critical evidence] in Price's red tomato. When he first mentioned the object it was a typical example of a common-sense fact, but by the time he finished his paragraph describing the tomato in detail it had become a highly criticized fact. Deducting from the description its dogmatic elements, we see that it was a penetrating critical hypothesis of the factual perception of a tomato.[3]

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[1] Ibid., pp. 16-17. [2] Ibid., p. 39.

[3] Ibid., pp. 40-41. Pepper is referring to H.H. Price's Perception (London: Methuen, 1932); on pp. 26-27 Pepper quotes relevant material from p. 3 of Price's work.

Pepper argues that critical evidence becomes critical as a result of corroboration. This corroboration falls into two categories which define two kinds of critical evidence. "Multiplicative corroboration" occurs when different investigators are able to repeat a particular fact (such as a pointer reading). "Structural corroboration" consists of evidence converging upon a single fact. The products of multiplicative corroboration Pepper calls "data." The products of structural corroboration he calls "danda;" these are "the facts that seem to be given as we note the extended corroboration of fact by fact."[1] Pepper shows the difference in the two kinds of evidence.

> [Multiplicative] Suppose I want to know whether a certain chair is strong enough to take a man's weight. I may sit in it myself. Perhaps I sit in it several times, taking this posture and that and dropping down in it with some force. And then, to be quite sure, I ask several of my friends to try sitting in it. If we all agree that the chair supports us firmly, we may feel justified in believing that the chair is a strong chair.[2]
>
> [Structural] Or I may use another method. I may examine the relevant facts about the chair. I may consider the kind of wood it is made of, the thickness of the pieces, the manner in which they are joined together, the nails and the glue employed, the fact that it was made by a firm that for many years has turned out serviceable furniture, the fact that the chair is an item of household furniture at an auction and shows evidence of wear as if many people had successfully sat in it, and so on. Putting all this evidence together, I should again feel justified in believing that the chair is a strong chair.[3]

The fact that structural corroboration depends on hypotheses is of prime importance to the concept of world hypotheses. It is necessary to elucidate the notion of multiplicative corroboration, however, in order to see why structural corroboration is important.

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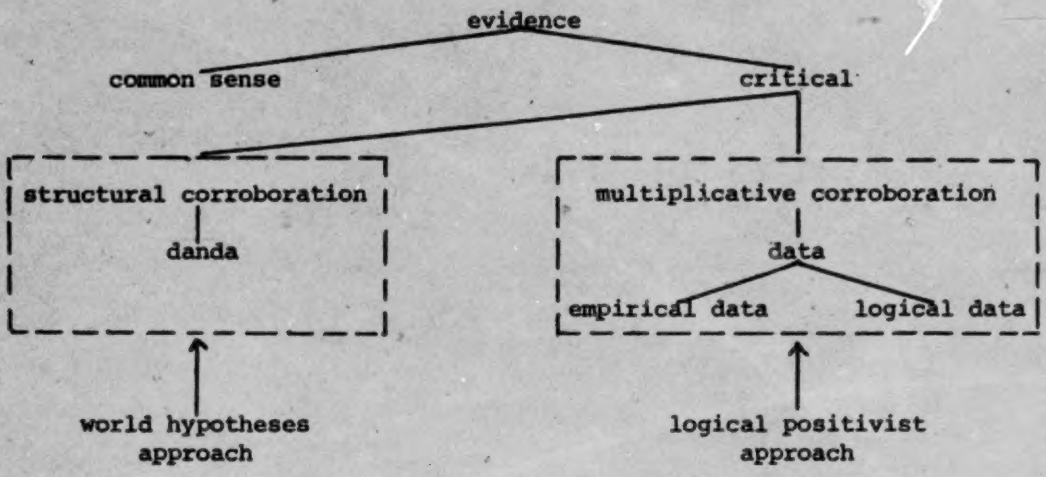
[1] *Ibid.*, p. 70. [2] *Ibid.*, p. 48. [3] *Ibid.*, p. 49.

Multiplicative corroboration produces two types of data: empirical and logical.[1] Empirical data consist of precise physical measurements and their observed relations to each other. The important feature of empirical data is that they are easy to corroborate; men can quickly agree about a pointer reading. This kind of agreement is also true for logical data.

> Logical data are the evidence for the validity of logical and mathematical transitions and for those organizations of such transitions which are called logical and mathematical systems. As with empirical data, so with logical data; the aim is to obtain types of transition so simple and obvious that any and all men observing them will agree that they are legitimate. These also have had their development out of common sense, and have reached their apex in symbolic logic just as empirical data have reached their apex in physics. The principle logical data [are] . . . substitution, inference, and adjunction.[2]

At this point it is helpful to represent diagramatically the distinctions Pepper is making.


evidence
common sense
critical
structural corroboration
danda
multiplicative corroboration
data
empirical data
logical data
world hypotheses approach
logical positivist approach

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[1] *Ibid.*, p. 52. [2] Ibid., pp. 57-58.

Pepper argues against the positivist position that knowledge should consist of beliefs founded on multiplicative corroboration only; that is, on empirical and logical data. The thrust of Pepper's criticism is that the positivist must make hypothetical claims about the ultimate realization of his position (since, at the moment, it is far from being realized), and these hypothetical claims constitute a metaphysical position.

> The gist of the matter is this: In order to set up refined data as the sole norm of evidence, it is necessary to deny the claims of danda, derived from various structural world theories, as alternative norms of evidence. To back up this denial an undogmatic dictatorial positivist must so assemble his data as to drive out the claims of alternative danda. Multiplicative corroboration alone will not do this, for it only establishes the data it establishes, and neither affirms nor denies the claims of any facts other than those, like pointer readings, by which man corroborates man. In order to assemble data so as to drive out alternative danda, such a positivist must make a structural hypothesis, and a world-wide one, such that fact corroborates fact throughout and every fact is a "datum." Then, and only then, can no alternative danda squeeze in. But then this positivist has developed a structural world hypothesis, and his "data" become actually danda of a certain sort.[1]

Since, according to Pepper, even the positivist eventually resorts to structural hypotheses, it is appropriate to begin an account of hypotheses through the positivist interpretation.

> To the positivist a hypothesis is a human convention for the purpose of keeping data in order; it has no cognitive value in itself. . . . To accord it cognitive value for itself is a misunderstanding. Cognitive value belongs where knowledge is. And what we know are data. A hypothesis is not a datum; it is simply a symbolic scheme for the arrangement of data, so that men can easily find and use the data they know.[2]

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[1] _Ibid._, pp. 67-69.

[2] _Ibid._, p. 71.

According to Pepper the positivists' position with regard to hypotheses is sound as long as no cognitive claims are made. But, some hypotheses do make cognitive claims.

> Our interest, therefore, will henceforth be focused upon structural hypotheses--of which world hypotheses are examples,--for these do make cognitive claims. They purport to inform us about the structure of the world.
>
> . . . .
>
> The cognitive value of such hypotheses is generated directly out of the mode of cognitive refinement which requires them. Structural corroboration cannot get along at all except by the aid of hypotheses which connect together the evidence that is corroborative. Even in our earlier common-sense example of structural corroboration having to do with the strength of a chair, the evidence would not have been convincing but for a set of hypothetical connections, mostly causal, which brought together the evidence toward the belief in the chair's strength.[1]

Pepper discusses the method by which the reliability of a crude hypothesis can be increased. A hypothesis can be made more reliable by increasing its precision or its scope.[2] Increasing the precision means "making it exactly fit, conform to, apply to, describe or in any other way strictly refer to the facts under consideration. . . ."[3] Increasing the scope of a hypothesis means finding more corroborative facts for it, and this eventually leads to a "world hypothesis."

> It thus becomes clear that, in the pursuit of reliability, structural corroboration does not stop until it reaches unlimited scope. For as long as there are outlying facts which might not corroborate the facts already organized by the structural hypothesis, so long will the reliability of that hypothesis be questionable. The ideal structural hypothesis, therefore, is one that all facts will corroborate, a hypothesis of unlimited scope. Such a hypothesis is a world hypothesis.[4]

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[1] *Ibid.*, pp. 74-75.

[2] *Ibid.*, p. 76.

[3] *Ibid.*

[4] *Ibid.*, p. 77.

The Root-Metaphor Theory

Pepper then discusses the root-metaphor theory, which is an effort to determine the origin of world hypotheses in order to isolate them and reveal their strengths and weaknesses.

> Here I shall offer a hypothesis concerning the origin of world theories--a hypothesis which, if true, shows the connection of these theories with common sense, illumines the nature of these theories, renders them distinguishable from one another, and acts as an instrument of criticism for determining their relative adequacy. . . . Such a theory of world theories seems to me much less important than the clarification it introduces into the field of cognition it covers. Our interest is not so much in the truth of a certain theory about world theories as in the cognitive value of the world theories themselves.[1]

Pepper's theory is that a world hypothesis develops from common sense. A developing world hypothesis usually requires refinement of the metaphor inspiring its development. Successive (and successful) refinement gives rise to categories which eventually form the framework of the world hypothesis. Pepper describes the process in the following way:

> The method in principle seems to be this: A man desiring to understand the world looks about for a clue to its comprehension. He pitches upon some area of common-sense fact and tries if he cannot understand other areas in terms of this one. This original area becomes then his basic analogy or root metaphor. He describes as best he can the characteristics of this area, or, if you will, discriminates its structure. A list of its structural characteristics becomes his basic concepts of explanation and description. We call them a set of categories. In terms of these categories he proceeds to study all other areas of fact whether uncriticized or previously criticized. He undertakes to interpret all facts in terms of these categories. As a result of the impact of these other facts upon his categories, he may qualify and readjust the categories, so that a set of categories commonly changes and develops. Since the basic analogy or root metaphor normally (and probably at least in part necessarily) arises out of common sense, a great deal of development and refinement of a set of categories is required if they are to prove adequate for a hypothesis of unlimited scope. Some root metaphors prove more fertile than others, have greater

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[1] *Ibid.*, pp. 84-85.

> powers of expansion and of adjustment. These survive in comparison with the others and generate the relatively adequate world theories.[1]

In developing the root-metaphor theory Pepper states four maxims.[2]

1. Root metaphors determine hypotheses: When we speak of different world hypotheses we are speaking of the development of alternative root metaphors, and "it is implied that there is some statement or number of statements which represent the world theory, its categories, and root metaphor at the height of its development."[3]

2. Each world hypothesis is autonomous. . . :

> i) It is illegitimate to disparage the factual interpretations of one world hypothesis in terms of the categories of another--if both hypotheses are equally adequate. . . .
> ii) It is illegitimate to assume that the claims of a given world hypothesis are established by the exhibition of the shortcomings of other world hypotheses. . . .
> iii) It is illegitimate to subject the results of structural refinement (world hypotheses) to the cognitive standards (or limitations) of multiplicative refinement. . . .
> iv) It is illegitimate to subject the results of structural refinement to the assumptions of common sense. . . .
> v) It is convenient to employ common-sense concepts as bases for comparison for parallel fields of evidence among world theories.[4]

3. Eclecticism is confusing:[5] There is nothing more encompassing than a world hypothesis. Therefore, to combine the best features of two or more world hypotheses is only to form another single world hypothesis which is internally inconsistent.

4. Concepts which have lost contact with their root metaphors are empty abstractions. . . . When a world theory grows old and stiff. . ., men begin to take its categories and subcategories for granted and presently forget where in fact these come from, and assume that these have some intrinsic and ultimate cosmic value in themselves. . . . Terms are only genuinely hypostatized, clearly, if some cognitive weight is given to their very emptiness, if the absence of evidence they have attained is actually used as evidence--word magic, in short.[6]

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[1] *Ibid.*, pp. 91-92. [2] *Ibid.*, pp. 96-114. [3] *Ibid.*, pp. 96-97.

[4] *Ibid.*, pp. 98-102. Italics omitted.

[5] *Ibid.*, p. 104. Italics omitted. [6] *Ibid.*, pp. 113-114. Italics omitted.

This is the framework in which Pepper discusses six world hypotheses. Two of these (animism and mysticism) he regards as inadequate on the grounds that they make dogmatic claims. The remaining four hypotheses (formism, mechanism, contextualism, organicism) Pepper regards as relatively adequate in the following sense.

> By the maxim of autonomy, we know that one world theory cannot be legitimately convicted of inadequacy by the judgment of another. How, then, do we discover that a theory is inadequate? By its own judgment of its own achievements in attaining complete precision in dealing with all facts whatever presented. A world theory, in other words, convicts itself of inadequacy. By its own logic, or refined canons of cognition, it acknowledges its own shortcomings in dealing with certain kinds of facts, or in dealing with them consistently with its dealing with other kinds of facts. These judgments, once made by the theories themselves, can then be compared externally. Theories which show themselves up as dealing much less adequately with the world-wide scope of facts than others are said to be relatively inadequate; the others, relatively adequate.[1]

As to the grounds for claiming that there are only four relatively adequate world hypotheses, Pepper makes these comments.

> The root-metaphor theory is simply a recognition of the fact that there are schools of philosophy, and an attempt to get at the roots of these schools. . . . The appearance of a great number of different world theories arises simply from the great number of combinations that can be made out of the parts of . . . the world hypotheses we have discussed. . . . Drop dogmatic claims from the large number of combinations , and the relatively small number of distinct world theories appear of themselves. . . .
>
> The situation is even further simplified by the discovery that out of the seven or eight basic world hypotheses, so derived from their root metaphors, four are to such a degree superior to the others in adequacy that they alone need be seriously considered. These also may some day be superseded, but the present situation, we believe, is one in which these four must be given equal or nearly equal weight in any cognitive judgment or evaluation where we want all the evidence we can get on a matter.[2]

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[1] Ibid., pp. 115-116.

[2] Ibid., pp. 328-329.

APPENDIX II

PRELIMINARY ANALYSIS

This preliminary analysis was undertaken prior to the development of the analytical scheme and aided in the formulation of that scheme. The material for examination was selected on the basis of its intuited implication of a world hypothesis and the analysis was done to support the initial intuition. The readings are not from science textbooks; an effort was made to select material relatively transparent to Pepper's categories.

For each world hypothesis the appropriate summary in Chapter II should first be read. In this appendix, the readings for each hypothesis are presented first, and are followed by the preliminary analysis. All line identification at the left of the quoted material has been added by this investigator.

Animism

The following is from a publication of the Watchtower Bible and Tract Society of New York, and implies categories of animism.

> Evolution has no explanation for the instinctive wisdom
> of animals. But the Bible does. The wisdom everywhere
> manifested in living things testifies to the fact that they
> were designed by an intelligent Creator, by God, as the Bible
> 5 shows. . . . Thus when we compare all the actual facts with
> the theory of evolution, we find that everywhere the theory
> is at odds with them. . . .

All

Whereas evolution cannot account for the beginning of life, the Bible can. All biological research shows that life comes only from life, verifying the principle of biogenesis. The Bible account in Genesis reveals God to be the source of all other life and is, therefore, in harmony with the facts of biogenesis. Psalm 36:9 identifies God as the life-giver: "For with you is the source of life."[1]

So by comparing the known facts, free from speculations, with the Bible, it can be seen that the Biblical record about the beginning of life is true.[2]

Since it is, as some say, God the Creator who permits wickedness, it would only be fair and right to listen to the explanation that God provides.

Where does God provide this information? Surely we cannot think that God, after creating man, would leave humankind without an inspired record that would reveal the true history of his dealings with mankind and his view of things. He has provided such a record. The Christian apostle Paul, a God-fearing man writing under the guidance of the Creator, stated:

"All Scripture is inspired of God. . . [this investigator's ellipsis] ." -- 2 Timothy 3:16,17.[3]

For his own good, a man needed God's guidance and direction. The reason why. . . is this: Man was not made to live or govern independently of God.

God did not give man the right or the ability either to live or to govern his affairs successfully without Him.[4]

God, in his own Word, identifies the creature that has been the chief inspirer of wickedness. It was he who corrupted Eve's integrity, and induced her to rebel against her righteous Creator.

He is an invisible wicked spirit creature. His invisibility should not make you doubt his existence. The existence of microorganisms as disease-causing factors was once doubted because they could not be seen with the naked eye, but that was not a valid reason for doubting their existence. The same can be said about this spirit creature.[5]

Responsibility for worldwide wickedness, then, rests primarily with Satan the Devil. . . . But the Devil is not the only invisible wicked creature. . . . Other wicked spirits, demons, are also responsible for the spread of wickedness. -- Revelation 12:9.[6]

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[1] Did Man Get Here by Evolution or by Creation? (New York: Watchtower Bible and Tract Society of New York, Inc., 1967), pp. 124-125.

[2] Ibid., p. 126. [3] Ibid., pp. 132-133. [4] Ibid., p. 136.

[5] Ibid., p. 144. [6] Ibid., p. 147.

An analysis of all these passages reveals a number of instances in which an animistic world hypothesis is projected. Three distinguishing features of animism appear most useful in the analysis, namely, the notion of infallible authority as the criterion for truth, the notion that there are controlling deities and subordinate spirits, and the notion that there are transcendent spirits which are the "life-blood" of entities.

Infallible authority as the criterion for truth appears in several statements. The Bible (holy book) is cited as an infallible authority for truth in "it can be seen that the Biblical record about the beginning of life is true" (16-17), and "surely we cannot think that God, after creating man, would leave humankind without an inspired record that would reveal the true history of his dealings with mankind and his view of things" (21-24). The authority of the Bible is again asserted as infallible because it is the product (at least indirectly) of an infallible spirit (God) (25-28). This is further supported by the words "God, in his own Word" (34).

The notion of controlling deities and subordinate spirits is evident in several parts of the text. "God the Creator who permits wickedness" (18-19) shows the controlling nature of the deity by the word "permits." This controlling nature is again brought out in "God did not give man the right. . . ." (32-33). The "control" lies in the extent to which the supreme spirit is able to "give" and "take" rights, privileges, etc.

According to the passage the supreme spirit (God) permits wickedness (18-19), and the "chief inspirer of wickedness" (35) is the Devil. It follows that God is a supreme and controlling spirit, while the Devil is a subordinate spirit. The notion of subordinate spirit is carried throughout the last passage (34-47). The term "spirit creature" is both conspicuous and identifying as an indication of an animistic hypothesis. It is also noticeable that there are even lesser subordinate spirits (demons) than the Devil (44-47).

Finally, it is evident that the transcendent spirit (God) is the "life-blood" of the individuals being controlled. Two statements speak particularly to this: "Psalm 36:9 identifies God as the life-giver" (14-15)and "God did not give man the . . . ability to live . . . without Him" (32-33).

Mysticism

The following is quoted from an article entitled "The Rush for Instant Salvation." The article is about the author's experiences during an "enlightenment session," including interviews with people connected with various forms of mysticism.

> What has carried us is the power of what we are promised: a sudden crack in the consciousness, a splitting open of the soul, when we are flooded with joyous certainty. A direct experience of who, exactly, we are. Salvation![1]
>
> The experience is found by taking Christ's word literally: "the kingdom of God is within you." Each person comes to his own experience of the truth, and all experiences are valid.[2]
>
> Bhajan says, "Let us meditate. . . . Inhale--meditate on the third eye. Now exhale, powerfully!" There is a loud, collective whoosh. Bhajan smiles. "Relax. This experience is your own. You got it, you did it. It is you alone who can raise the

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[1] Sara Davidson, "The Rush for Instant Salvation," Harper's Magazine, July, 1971, p. 40.

[2] Ibid., p. 41.

consciousness within you. Feel free, learn from everybody. Whatever can help you to reach the truth is the most beautiful thing. God bless you."[1]

The definition on which most spiritual teachers would agree is that enlightenment is a direct, personal experience of the truth. It is a truth which comes to one intuitively, which cannot be proved rationally but is felt so strongly as to be beyond doubt. Enlightenment has led to many different perceptions of truth, but consistent in all enlightenment experiences has been a sense of unity and continuity, of oneness with infinity.[2]

Enlightenment came in 1964, on a day like any other. Charles was standing. . . "when this direct, conscious experience occurred. I realized that I am a God of infinite ability, and that the purpose of life is for us all to become conscious of each other as the individual Gods we are. I experienced this as the truth--beyond the realm of doubt. It's pure experience."[3]

A nineteen-year old boy in Berkeley. . .says "I don't know what common sense is anymore. I can't tell what's valid and what isn't." He fails to discern hype, or techniques that smack of quackery. He does not consider the evidence when a spiritual teacher is charged in court with fraud or financial mismanagement.[4]

Here we see a number of statements which clearly project a mystical world hypothesis. For example, ". . . flooded with joyous certainty. A direct experience of who exactly, we are. Salvation!" (3-4) can be identified as projecting mysticism in at least two ways. "Joyous certainty" indicates that the experience is certain and indubitable and emotionally ecstatic. The experience is claimed to be "direct" (3) which shows its immediate and totally uninterpreted nature. The revelatory and cognitive qualities of the emotion are projected by "experience of the truth, and all experiences are valid" (7).

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[1] Ibid. [2] Ibid., p. 42. [3] Ibid.

[4] Ibid., p. 49.

"Enlightenment is a direct, personal experience of the truth" (16) projects the immediate and cognitive qualities of the mystical experience. The next statement (17-18) shows the revelatory, immediate, and certain nature of the experience. "Consistent in all enlightenment experiences has been a sense of unity and continuity, of oneness with infinity" (20-21)--this projects the first three mystical categories. The phrases "of unity and continuity, of oneness with infinity" express the ideas of fusion and inclusiveness, and can be seen as a reflection of the way in which love acts on things in the universe.

"I experienced this as the truth--beyond the realm of doubt" (26-27) also reveals the cognitive and revelatory nature of the experience with an emphasis that the experience is certain and indubitable. The mystical theory of truth (revelation of the experience is the truth) is blatantly projected in many of these statements. For example, it is illustrated in the last paragraph (28-32). A mystical theory of truth is bound up in the immediate revelation of an emotionally ecstatic experience and has nothing to do with "evidence" (the concept of evidence comes out of other world hypotheses). Rather than saying that the boy "does not consider the evidence" (31, investigator's emphasis), it might be more appropriate to say that he does not consider evidence. And when the boy says "'I can't tell what's valid and what isn't'" (29-30), he is merely being inconsistent with the categories of mysticism since it is probably the case that he can tell what is valid within a mystical world hypothesis. Had he been consistent, his statement might have been "I can't tell, using the criteria of other world hypotheses (mechanism, formism, contextualism, etc.), what is valid and what isn't."

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Formism

The categories of a formist world hypothesis will now be applied to three separate passages. The first passage is from Cassirer's *Language and Myth*. It is important to note that there is no effort to label Cassirer's position as formistic. Rather, what will be shown is that elements of his critique reveal the formist attitudes taken by others. Cassirer is discussing theories on the origin of myth.

> Here in the realm of spooks and daemons, as well as in the higher reaches of mythology. . .it was always assumed that the essence of each mythical figure could be directly learned from its name. The notion that name and essence bear a necessary and internal relation to each other, that the name does not merely denote but actually *is* the essence of its object, that the potency of the real thing is contained in the name--that is one of the fundamental assumptions of the mythmaking consciousness itself. Philosophical and scientific *mythology*, too, seemed to accept this assumption. What in the spirit of myth itself functions as a living and immediate conviction becomes a postulate of reflective procedure for the science of mythology; the doctrine of the intimate relation between names and essences, and of their latent identity, is here set up as a methodological principle. . . .
>
> It might seem an idle pursuit to hark back to such points of view, which have long been abandoned by the etymology and comparative mythological research of today, were it not for the fact that this standpoint represents a typical attitude which is ever recurrent in all related fields, in mythology as in linguistic studies, in theory of art as well as in theory of knowledge. For Max Müller the mythical world is essentially a world of illusion--but an illusion that finds its explanation whenever the original, necessary self-deception of the mind, from which the error arises, is discovered. This self-deception is rooted in language, which is forever making game of the human mind, ever ensnaring it in that iridescent play of meanings that is its own heritage. And this notion that myth does not rest upon a positive *power* of formulation and creation, but rather upon a mental *defect*--that we find in it a "pathological" influence of speech--this notion has its proponents even in modern ethnological literature.
>
> But when we reduce it to its philosophical lowest terms, this attitude turns out to be simply the logical result of that naive realism which regards the reality of objects as something directly and unequivocally given, literally something tangible. . .as Plato says. If reality is conceived

> in this manner, then of course everything which has not this solid sort of reality dissolves into mere fraud and illusion. This illusion may be ever so finely wrought, and flit about us in the gayest and loveliest colors; the fact remains that this image has no independent content, no intrinsic meaning. It does indeed reflect a reality--but a reality to which it can never measure up, and which it can never adequately portray. From this point of view all artistic creation becomes a mere imitation, which must always fall short of the original. . . . Moreover, from this standpoint, not only myth, art, and language, but even theoretical knowledge itself becomes a phantasmagoria; for even knowledge can never reproduce the true nature of things as they are, but must frame their essence in "concepts."[1]

Lines (1-15)--The first strong evidence that Cassirer is revealing a formist position occurs with "the notion that name and essence bear a necessary and internal relation to each other, that the name does not merely denote but actually is the essence of its object, that the potency of the real thing is contained in the name. . . ." (4-7). This statement reflects formism because it can be analyzed parsimoniously using the formist categories. The term "real thing" (7) refers to a particular while "essence" (4, 6) refers to character (relation or quality or both).

Another characteristic of formism is also present: the idea of similarity (which gives rise to a correspondence theory of truth). "The notion that name and essence bear a necessary and internal relation to each other" (4-5) suggests correspondence or similarity between the "name" and the "essence." There is a similarity or correspondence between two things: a name and a characteristic. But the statement goes further than that with the claim that "the name . . . is the essence of its object. . . ." (5-6). This is more than just correspondence between two things--it is correspondence to such an extent that the two things are one and the same. This might be termed "ultimate correspondence" and represents a "collapsing" of two similar things.

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[1] Ernst Cassirer, Language and Myth (New York: Dover Publications Inc., 1953), pp. 3-7.

Lines (33-51)--Cassirer labels the position he has been discussing as "naive realism," (35), and Pepper notes that formism is often called realism.[1] Several sentences seem to project a formistic world hypothesis in this section. "It does indeed reflect a reality--but a reality . . . which it can never adequately portray" (43-44) is like Pepper's concept of a norm "which may rarely be fulfilled."[2] In this case "reality" can be interpreted as a norm while the language used to represent (or correspond to) that norm never can represent it quite adequately. And, of course, this analysis also holds for the sentence "all artistic creation becomes a mere imitation, which must always fall short of the original" (45-46). The sentence "for even knowledge can never reproduce the true nature of things as they are, but must frame their essence in 'concepts'" (49-51) could be reworded to read "for even knowledge can never reproduce the form (true nature) of particulars (things) as they concretely exist (are), but must frame their form (essence) in 'concepts.'"

The second quote is from Hempel's Philosophy of Natural Science.

> Theories are usually introduced when previous study of a class of phenomena has revealed a system of uniformities that can be expressed in the form of empirical laws. Theories then seek to explain those regularities and, generally, to afford a deeper and more accurate understanding of the phenomena in question. To this end, a theory construes those phenomena as manifestations of entities and processes that lie behind or beneath them, as it were. These are assumed to be governed

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[1] Pepper, World Hypotheses, p. 141. [2] Ibid., p. 163.

> by characteristic theoretical laws, or theoretical principles,
> 10 by means of which the theory then explains the empirical uni-
> formities that have been previously discovered, and usually
> also predicts "new" regularities of similar kinds.[1]

Pepper claims that "persons who accept the theory that there are laws of nature, and that the aim of science is to discover these laws, which nature 'follows', seem (if their words do not belie them) to imply that these laws are norms which regulate (literally render regular) the occurrences of nature."[2] The passage from Hempel's Philosophy of Natural Science suggests this position. The basis for the inference lies in the use of several terms and phrases which point to the notion that laws are regulating norms. An example is ". . . when previous study . . . has revealed a system of uniformities that can be expressed in the form of empirical laws" (1-3). The verb form "has revealed" suggests that something was there to be revealed. In this case that "something" is a law (norm) and its existence is real but not concrete. According to Pepper's formist interpretation, such laws are subsistent forms.

Further support for the inference that laws are considered as subsistent forms is the statement: "a theory construes those phenomena as manifestations of entities and processes that lie behind or beneath them " (6-8). The clause "that lie behind or beneath them" (7-8) suggests concrete existence in the case of "entities," and (probably) subsistence in the case of "processes." In either case, the clause seems to refer to a reality of the nature of "forms." The last sentence (8-12) contains two verb forms which, in some circumstances, appear to indicate a formistic hypothesis: (to be) governed and (have been) discovered. The sentence "these [phenomena] are assumed to be governed by . . . laws" (8-9) suggests Pepper's contention that in formism "laws are norms which regulate . . . the occurrences of nature."[1] The sentence "the theory . , . explains the empirical uniformities that have been previously discovered" (10-11) also implies that the laws (forms) exist as subsistent reality which are discovered.

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[1] Carl G. Hempel, Philosophy of Natural Science (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1966), p. 70.

[2] Pepper, World Hypotheses, p. 166.

The third quote is from Campbell's *What is Science?*.

> And now let us turn again to theories. Here, it is true, we cannot apply directly the criterion of universal assent. There is actually much more difference of opinion concerning the value of theories than there is concerning the value of laws; and it is impossible to force an agreement as it can be forced in the case of laws. And while that difference of opinion persists we must freely admit that the theory has not more claim on our attention than any other; it is a fairy tale which may be true, but which is not known to be true. But in process of time the difference of opinion is always resolved; it vanishes ultimately because one of the alternative theories is found to predict true laws and the others are not. It is for this reason that prediction by theories is so fundamentally important; it enables us to distinguish between theories and to separate from among our fairy tales that one which nature is prepared to accept and can therefore be transferred from the realm of fantasy to that of solid fact. And when a theory has been so transferred, when it has gained universal acceptance because, alone of all possible alternatives, it will predict true laws, then, although it has purpose and value for us because it renders the world intelligible, it is so clearly distinguished from all other attempts to achieve the same purpose and to attain the same value that the ideas involved in it, like the ideas involved in laws, have the certainty and the universality that is characteristic of real objects. A molecule is as real, and real in the same way, as the gases the laws of which it explains. It is an idea essential to the intelligibility of the world not to one mind, but to all; it is an idea which nature as well as mankind accepts. That, I maintain, is the test and the very meaning of reality.[2]

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[1] Pepper, *World Hypotheses*, p. 166.

[2] Norman Campbell, *What is Science?* (New York: Dover Publications Inc., 1953), pp. 107-108.

This analysis of the quoted material from Campbell's work What is Science? will focus both on his assertion that a good theory is one that "is found to predict true laws" (12), and on his assertion that the ideas involved in a good theory "have the certainty and the universality that is characteristic of real objects" (24-25). The first claim (9-12) can be said to imply a formistic world hypothesis because a correspondence theory is suggested as a strategy for recognizing a true law. According to this strategy, a true law would be one in which the phenomena observed correspond in appropriate ways to the statement of the law. While the other theories of truth could be applicable to recognizing a "true" law, the words "that one which nature is prepared to accept" (15-16) plausibly support the inference that some kind of correspondence is intended by Campbell. What could it mean to say that nature is prepared to accept a theory? Clearly, Campbell is using a metaphor, here, but the meaning of the metaphor seems most plausibly read as a correspondence between what is observed and a theory or law.

The notion that the ideas involved in a good theory "have the certainty and the universality that is characteristic of real objects" (24-25) suggests a formist hypothesis in a unique way. Campbell states further that ideas in laws and real objects are "real" in the same way. His reference to "real objects" is undoubtedly the same as Pepper's objects having "concrete existence" (particularized characters).[1] And, within formism, molecules, atoms, etc. are forms of matter. Campbell appears to have collapsed two of the categories--particulars and forms--by asserting that the reality is identical in both cases. The argument for saying that these statements reflect formism is simply that no other analysis (using other world hypotheses) can be brought to bear on the statements in such a parsimonious way.

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[1] Pepper, World Hypotheses, pp. 167-168.

Mechanism

Two pieces of material will be analyzed using the framework of the mechanistic world hypothesis. The first selection is from a newspaper article titled "Scientists feel key to learning may hide between nerve cells."[1]

> Scientists have a "gut feeling" that the key to learning and memory may reside in the processes carried out in the region between the end of one nerve cell and the beginning of another.
>
> Dr. John E. Dowling of Harvard University said in an interview yesterday that scientists "know virtually nothing about the physical basis for memory and learning, but we have a gut feeling it's in the synapse, where it appears one could modify the processes a great deal."
>
> Nerve impulses are propagated across the synapse by the release of chemicals from the axon. "There are hundreds of ways you could modify that system. The flexibility is tremendous," Dr. Dowling said.
>
> But he stressed that there are as yet no substantial theories about how this affects learning. Scientists are still trying to understand the exact nature of the synaptic processes.[2]

The very first statement in this Toronto Globe and Mail article provides a clue to the projection of mechanism. This inference is based partly on the assumption that "key" means "explanation" and, therefore, there is an intuition on the part of scientists that a suitable explanation for phenomena such as learning lies in processes happening at an unobservable level and lying in the primary categories. That is to say, the force of this analysis turns on the difference between the secondary and primary categories of mechanism. For example, it is asserted that an explanation for the phenomenon of learning lies in chemical processes. These processes are unobservable (not detected by our senses), and therefore lie in the primary categories. These processes, then, are inferred from observable phenomena in the secondary categories. The chemical reactions operating within cells are not the objects of perception, but lie in the primary categories which must be inferred from phenomena of human perception (lying in the secondary categories).

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[1] The Globe and Mail (Toronto), February 26, 1972.

[2] Ibid.

A further suggestion of a mechanistic world hypothesis lies in an analysis of the sense in which "processes" (2) is used. It appears, primarily from the context of the rest of the article, that "process" means some kind of chemical reaction which operates according to mechanistic principles (discrete particles, action by contact, specified location). The words "processes carried out in the region between . . ." (2-3) make clear the effort to specify a location for the mechanism and consequently suggests the projection of a mechanistic hypothesis. Pepper has shown that in mechanism "locations determine the mode of functioning of the machine, and until these are specified there is no way of getting an exact description of the machine."[1] It seems clear from the meaning imparted in the statement (1-4) that the location of a process which explains learning and memory is an important issue.

The phrase "physical basis for memory and learning" (7) indicates a search for discrete, physical units which are the elementary components of more sophisticated phenomena called memory and learning. The statement "one could modify the processes a great deal" (8-9) projects mechanism. The analysis centers on "modify." An assumption seems to be that if discrete mechanical components of a phenomenon can be located, then they can be controlled or manipulated. In this case the "processes" are located and, upon their location, are subject to "modification" (control). The idea of "control" over discrete units (possibly, but not necessarily, ultimate particles) brings up the larger issue of control and controlled experiments. Briefly stated, controlled experiments assume mechanistic categories because the experiments are set up with the intention of finding a causal thing (assuming discreteness) and the research model--for finding "mechanisms" in general--assumes the paradigm of action by contact. The notion of "control" or "manipulation" is also implicit in Pepper's treatment of mechanism. This is because, according to Pepper, both secondary and primary qualities are subject to certain laws which hold among them. It can be further assumed that action which produces "manipulation" (modification, control, etc.) is itself a combination of secondary and primary qualities and that the nature of the very action is dictated by regulatory laws. And, if an inferred primary quality can be located, then it is subject to purposeful action or manipulation (say, indirectly on the part of an experimenter). In a mechanistic hypothesis, then, "things" are subject to the action of other "things" by virtue of the laws that hold among them (Pepper's third category). In the particular case under discussion, "processes" can be seen as a constellation of primary qualities (related by primary laws--dictating the various chemical reactions--in a field of location) subject to outside (discrete) forces consisting of similar combinations of primary categories.

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[1] Pepper, World Hypotheses, p. 191.

A mechanistic world hypothesis seems also to be projected in the next two paragraphs (10-17). "Nerve impulses," "synapse," "chemicals," and "axon" (10-11) are all constellations of primary qualities which are inferred in complex ways from observable phenomena. As Pepper explains, "what we experience are secondary qualities only, from which as evidences we infer the mechanical efficient structure of the universe."[1] And, in those terms,"learning" can be seen as a secondary quality which is ultimately explained by the primary categories.

The second selection comes from Weisskopf's Knowledge and Wonder[2] (1962 Edison Foundation award for the best science book for youth).

> Today the different natural sciences are no longer independent of each other. Chemistry, physics, geology, astronomy and biology are all linked together, and all are treated in this book, though some at greater length than the others. Physics, being the basis of all the natural sciences, gets the main emphasis--in particular, atomic physics since everything in Nature is made of atoms. What is stressed in the book is the trend toward universality in science, from the elementary atomic particle to the living world, a common point of view whose realization seems nearer because of the enormous progress the last few decades have brought in our understanding of atoms, stars and the living cell.[3]
>
> There is no question in the author's mind that the Einstein theory is one of the greatest achievements of physics and of all science. It has revolutionized our ideas of space and time to such an extent that without Einstein no exact quantitative consideration of space and time is possible. Einstein's ideas, therefore, play a decisive role in the quantitative formulation of many scientific problems.[4]

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[1] Pepper, World Hypotheses, p. 216.

[2] Victor F. Weisskopf, Knowledge and Wonder: The Natural World As Man Knows It (Garden City, New York: Doubleday & Company, 1966).

[3] Ibid., pp. 9-10. [4] Ibid., p. 10.

In order to get at the fundamental features of the structure of matter, we must begin our study with simple substances. At the start we shall not consider organic substances, such as wood or the skin of our bodies, whose structure is intricate and seems to be a complicated combination of substructures.[1]

Can we subdivide a certain amount of a given substance indefinitely or is there a smallest amount? The answer to this fundamental question is well known today. There is a smallest unit of every substance and it is called a molecule, and in some substances an atom.[2]

Chemical analysis has shown beyond shadow of a doubt that living objects consist of the same kinds of atoms as non-living things. In fact, living matter consists mainly of the four elements carbon, oxygen, hydrogen, and nitrogen, with traces of other elements such as iron, phosphorus, and magnesium. There is not the slightest indication that living matter contains any special material or that the laws of interaction between the atoms are different. The phenomena of life, therefore, must be the result of ordinary interactions between atoms and molecules--very special molecules, to be sure, of a structure and complication that distinguish them strikingly from the molecules of lifeless matter.

Today we are far from a complete understanding of how the interaction of these molecules can give rise to the phenomena of life. In the last two decades, however, biological research has provided so many new insights into the molecular structure of life that we already can form a vague idea of what goes on in living matter.[3]

Although many questions of human and animal development are unanswered, the following ideas stand out clearly: Each species with all its organs, nerves, bones, and brain develops biologically from its germ cell according to the plan laid out in the nucleic acid macromolecule. Here atomic physics and life in its highest form are intimately connected. Each nucleotide in the long chain has its well-defined quantum state, which is the basis of its specific character. They are tied together by electrons in typical quantum patterns, which are stable enough to maintain the order to the chain in spite of the heat motions and other disturbing effects in the cell. Upon this order rest not only the development of the individual but also the propagation of the species. The stability of the quantum patterns in the DNA is the guarantee that the children are basically like their parents, that the species is maintained. The various forms of life are a reflection of the various ways of combining nucleotides in the nucleic acid. The constancy of these forms, the recurrence in each generation, is a reflection of atomic stability.[4]

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[1] _Ibid._, p. 84. [2] _Ibid._, p. 85. [3] _Ibid._, p. 199.

[4] _Ibid._, p. 222.

Analysis of these passages from Knowledge and Wonder clearly shows elements of a mechanistic world hypothesis. "Since everything in Nature is made of atoms" (6-7) is a straightforward statement of the particulate nature of the universe. This is consistent with Pepper's assertion that "the traditional discrete mechanism is the theory of . . . elementary particles distributed in space and time."[1]

One of the characteristics of a mechanistic world hypothesis is the idea that phenomena need to be quantified so that one can understand the essence of the primary qualities that eventually give rise to observable phenomena. Pepper says that "we notice that the parts of the machine are all ultimately expressed in exact quantitative terms quite different from the objects as viewed in their common-sense guise."[2] The statements ". . .without Einstein no exact quantitative consideration of space and time is possible" (16-17), and "Einstein's ideas . . . play a decisive role in the quantitative formulation of many scientific problems" (17-19) reflect this concern for quantification.

Weisskopf's assertion that the phenomena of life are the result of interactions between atoms and molecules (37-38) projects a mechanistic hypothesis in the sense that underlying that assertion appears to be the notion that ultimately observable phenomena can be reduced to (explained by) complex interactions among primary qualities. This general idea is brought out again in the next paragraph (42-47). "What goes on in living matter" (46-47) can be read as "what makes life work" or "what the mechanism is that gives rise to life losing the meaning of the original statement. This projects a mechanistic world hypothesis in that explanations of observable phenomena ultimately depend on the interactions of discrete constellations of primary qualities (atoms and molecules).

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[1] Pepper, World Hypotheses, p. 201.

[2] Ibid., p. 192.

The statements in (48-65) provide clues to the projection of a mechanistic world hypothesis. The theme is, again, that observable phenomena (secondary qualities) are produced by (accounted for, explained by, or reduced to) inferred mechanisms involving interactions among primary qualities. Several observable phenomena are accounted for in this manner: "human and animal development" (48), "propagation of the species" (59-60), and "children are basically like their parents" (61-62). Such phenomena are accounted for by inferred constellations of primary qualities: "according to the plan laid out in the nucleic acid macromolecule" (51-52), "each nucleotide in the long chain has its well-defined quantum state" (53-54), "electrons in typical quantum patterns" (55-56), "quantum patterns in the DNA" (60), "combining nucleotides in the nucleic acid" (63-64), and "atomic stability" (65).

Contextualism

Four sections are analyzed using the framework of the contextual world hypothesis. The first selection is from E.J. Meehan's Explanation in Social Science: A System Paradigm.[1]

> There are other reasons for separating the empirical and the logical aspects of explanation that should not be overlooked. Their merger or fusion tends to blur the distinction between logical competence and possession of field-relevant knowledge--knowledge of relations that have held in the past, of attempts at explanation already rejected, of explanations accepted in related fields, etc. The adequacy of an explanation cannot be judged solely on logical grounds; some measure of logical

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[1] Eugene J. Meehan, Explanation in Social Science: A System Paradigm (Homewood, Illinois, The Dorsey Press, 1968).

competence is needed, but field-relevant knowledge is also essential. Each type of competence plays a different role in explanation, raising its own problems and requiring its own criteria of judgment. The crucial problem, fitting empirical data and logical propositions, is not a question that logic alone can settle--statisticians who seek to solve the problem by formal techniques not to the contrary. Separation of logic and empirical evidence calls attention to the need for both kinds of knowledge and reduces the possibility that either might be ignored.

Finally, by defining explanation in logical terms and ignoring the purposes for which explanations are used, the deductive paradigm in effect produces a single-factor standard for explanation and eliminates the possibility of grading explanations according to their usefulness. All deductive explanations are of a single quality. If the purpose for which explanations are used is added to the evaluative schema, grading is not only possible but necessary. And reference to purpose can provide the criteria needed for grading. The usefulness of grading may not be apparent in a highly developed field like physics but in the social sciences, where all explanations are imperfect, the introduction of grading or evaluation is enormously helpful.[1]

If knowledge is organized human experience, the manner in which experience is organized (including the processes by which explanations are created or formulated) will depend on the operation of the perceptive and cognitive apparatus in man and on the purposes for which knowledge is needed and used. The perceptive and cognitive structures define the limits of the possible; human purposes determine the value and significance of what is possible. I am here adopting the point of view called instrumentalism, i.e., the belief that knowledge is only a tool or instrument, hence that it can be evaluated only in terms of its human uses--its value to man. The corollary to that position, which is called nominalism, asserts that the meaning of words lies in the conventions that define their use, and therefore denies that words can have any "essential" meaning, any "real" counterpart in the natural universe. From this point of view, claims to know cannot be judged against absolute truth or unvarying reality because man cannot assert on defensible grounds the existence of absolute truth or unvarying reality. The quality of knowledge depends on the purposes that it will serve.

A claim to know is therefore no more than an assertion to the effect that a particular way of organizing human experience is useful for a particular purpose. Without a statement of purpose, usefulness cannot be judged. There is no such thing as "usefulness in general." Use is related to a particular end. It follows that there can be no general procedures for

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[1] Ibid., pp. 11-12.

> organizing human experience (in effect, no general theories without specific referrants) and no general procedures for evaluating claims to know. Further, ways of organizing experience (explanations and theories) are neither true nor false since there can be no criteria for judging them so. Either they serve a given purpose or they do not (within the realm of scientific knowledge) and that is determined by pragmatic test. There are therefore no general explanations; all explanations must make reference to specific events and relate to specific purposes.[1]

Lines (1-31)--The first section quoted from Meehan projects the contextualist position that there are no permanent and absolute structures in nature. Meehan states that ". . . field-relevant knowledge is also essential" (9-10) and that "each type of competence plays a different role in explanation, raising its own problems and requiring its own criteria of judgment." (10-12). This projects the attitude that there is no single or absolute criterion for judging explanations but rather the judgment depends on the kind of explanation and its use: in short, it depends on context.

The last paragraph of the first section (19-31) projects a contextualist framework in several respects. Meehan's insistence on ". . . grading explanations according to their usefulness" (22-23) provides for levels of reality, all of which are in one sense equally real. Pepper has stated that, in contextualism,

> there is no cosmological mode of analysis that guarantees the whole truth or an arrival at the ultimate nature of things. On the other hand, one does not need to hunt for a distant cosmological truth, since every present event gives it as fully as it can be given.[2]

Meehan proposes that "usefulness" be the criterion for an adequate explanation which is consistent with Pepper's "successful working theory" for contextualistic truth.

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[1] Ibid., pp. 17-18.

[2] Pepper, World Hypotheses, p. 251.

The last statement (27-31) in this paragraph is interesting in that it shows that Meehan is transparent to a contextualist position. The justification for "grading explanations according to their usefulness" (22-23) is that "the introduction of grading or evaluation is enormously helpful" (30-31). In short, the justification of usefulness as a criterion for explanation is usefulness.

Lines (32-67)--The second quoted portion reflects a contextualist hypothesis in several ways. ". . .The manner in which experience is organized . . . will depend on the operation of the perceptive and cognitive apparatus in man and on the purposes for which knowledge is needed and used" (32-36) implies that the organization of experience depends on context, one element of that context being the biological limitations of man, the other element being the purpose for which the organization is used. ". . . Claims to know cannot be judged against absolute truth or unvarying reality because man cannot assert on defensible grounds the existence of absolute truth or unvarying reality" (47-50)--this assumes that knowledge depends on context and that there are no absolute, permanent structures in nature.

The final paragraph (52-67) reflects contextualism by stressing context and utility. The reference to context runs through the entire paragraph and is summarized in the last statement: "there are therefore no general explanations; all explanations must make reference to specific events and relate to specific purposes" (65-67). The context here consists of "specific events" and "specific purposes." There are no general explanations; all explanations depend upon the context in which they are made.

Utility ("usefulness") is the criterion by which Meehan judges the value of explanations. "A claim to know is . . . an assertion . . . that a particular way of organizing human experience is useful for a particular purpose." (52-54). "Without a statement of purpose, usefulness cannot be judged" (54-55). These statements project the "successful working" theory of operational truth by putting the burden on the utility or successful functioning of knowledge claims as the criterion of their worth.

The second selection is from Michael Polanyi's The Tacit Dimension.[1]

> I shall reconsider human knowledge by starting from the fact that we can know more than we can tell. This fact seems obvious enough; but it is not easy to say exactly what it means. Take an example. We know a person's face, and can recognize it among a thousand,indeed among a million. Yet we usually cannot tell how we recognize a face we know. So most of this knowledge cannot be put into words. But the police have recently introduced a method by which we can communicate much of this knowledge. They have made a large collection of pictures showing a variety of noses, mouths, and other features. From these the witness selects the particulars of the face he knows, and the pieces can then be put together to form a reasonably good likeness of the face. This may suggest that we can communicate, after all, our knowledge of a physiognomy, provided we are given adequate means for expressing ourselves. But the application of the police method does not change the fact that previous to it we did know more than we could tell at the time. Moreover, we can use the police method only by knowing how to match the features we remember with those in the collection, and we cannot tell how we do this. This very act of communication displays a knowledge that we cannot tell.

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[1] Michael Polanyi, The Tacit Dimension (Garden City, New York: Doubleday & Company, 1967).

There are many other instances of the recognition of a characteristic physiognomy--some commonplace, others more technical--which have the same structure as the identification of a person. We recognize the moods of the human face, without being able to tell, except quite vaguely, by what signs we know it. At the universities great efforts are spent in practical classes to teach students to identify cases of diseases and specimens of rocks, of plants and animals. All descriptive sciences study physiognomies that cannot be fully described in words, nor even by pictures.[1]

Here we see the basic structure of tacit knowing. It always involves two things, or two kinds of things. We may call them the two terms of tacit knowing. In the experiments the shock syllables and shock associations formed the first term, and the electric shock which followed them was the second term. After the subject had learned to connect these two terms, the sight of the shock syllables evoked the expectation of a shock and the utterance of the shock associations was suppressed in order to avoid shock. Why did this connection remain tacit? It would seem that this was due to the fact that the subject was riveting his attention on the shock-producing particulars only in their bearing on the electric shock.

Here we have the basic definition of the logical relation between the first and second term of a tacit knowledge. It combines two kinds of knowing. We know the electric shock, forming the second term, by attending to it, and hence the subject is *specifiably* known. But we know the shock-producing particulars only by relying on our own awareness of them for attending to something else, namely the electric shock, and hence our knowledge of them remains *tacit*. This is how we come to know these particulars, without becoming able to identify them. Such is the *functional relation* between the two terms of tacit knowing: *we know the first term only by relying on our awareness of it for attending to the second.*[2]

Physiologists long ago established that the way we see an object is determined by our awareness of certain efforts inside our body, efforts which we cannot feel in themselves. We are aware of these things going on inside our body in terms of the position, size, shape, and motion of an object, to which we are attending. In other words we are attending *from* these internal processes *to* the qualities of things outside. These qualities are what those internal processes mean to us. The transposition of bodily experiences into the perception of things outside may now appear, therefore, as an instance of the transposition of meaning away from us, which we have found to be present to some extent in all tacit knowing.[3]

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[1] *Ibid.*, pp. 4-5. [2] *Ibid.*, pp. 9-10. [3] *Ibid.*, pp. 13-14.

Lines (1-32)--The analysis of Polanyi's writing bears heavily on Pepper's distinction between "quality" and "texture" in contextualism. For example the statement "from these the witness selects the particulars of the face he knows, and the pieces can then be put together to form a reasonably good likeness of the face" (11-13) implies these two categories. The intuited quality of the whole face is the focus of attention; that is, the whole face is what is being known. The textures that make up the quality of the whole face are the eyes, ears, nose, mouth, etc. ("particulars" in Polanyi's terms).

A similar analysis is again applicable to a later statement. "We recognize the moods of the human face, without being able to tell, except quite vaguely, by what signs we know it" (26-28). In this case the quality being apprehended is the "mood," and specific "signs" constitute the textures which go to make up the whole. It is also evident that the various signs are fused to produce the whole. Polanyi's reference to not "being able to tell, except quite vaguely" (27) by what signs we recognize the mood of a face is a case in which the fusion is not complete. If the fusion were complete we would never be able to tell the signs by which we recognize the mood of a face.

Lines (33-57)--The second quoted section also projects elements of the quality or event being focused on, in this case the avoidance of a shock. The fused textures that make up that quality are "shock syllables" and "shock associations" (36).

Polanyi contends that we often have only a tacit awareness of the textures that make up a quality. Pepper states that "generally there is some degree of qualitative integration in an event, in which case the fusion of the event quality is relaxed and the qualities of the details of the texture begin to be felt in their own right *though still as within the quality of the event* (investigator's emphasis)."[1] This position is projected when Polanyi states that "such is the *functional relation* between the two terms of tacit knowing: *we know the first term only by relying on our awareness of it for attending to the second*" (55-57). That is, the tacit knowledge of the textures is in terms of the explicit knowledge of qualities.

Lines (58-69)--In the final paragraph it is apparent that Polanyi's use of the term "quality" is similar to Pepper's use. Pepper claims that the "quality [of an event] is roughly its total meaning. . . . The quality of a given event is its intuited wholeness or total character. . . ."[2] And Polanyi states that

> we are attending *from* these internal processes *to* the qualities of things outside. These qualities are what those internal processes *mean* to us (63-66).

The tacit internal processes, then, are the textures by which we know or intuit the quality or whole.

The third quotation related to contextualism comes from Roszak's *The Making of a Counter Culture*.[3] It is from his brief analysis of *Gestalt Therapy*, by Perls, Hefferline, and Goodman.

> I will try simply to draw out four major characteristics of Gestalt which one finds echoed throughout Goodman's writings and which seem to be precisely the kind of first principles the counter culture is moving toward.
>
> (1) There is, first of all, the mystical "wholism" which the therapy inherits from Gestalt theories of perception. For the Gestaltists, perceptions are not piecemeal impressions printed by the "objective" world on the passive wax of the

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[1] Pepper, *World Hypotheses*, p. 244. [2] *Ibid*., p. 238.

[3] Theodore Roszak, *The Making of a Counter Culture* (Garden City, New York: Doubleday & Company, 1969).

> senses, but rather patterned wholes which are created by a strange and beautiful collaboration between the perceiver and the perceived. Generalizing this rich insight to life as a whole, Gestalt therapists envision a purposive give and take between every organism and its environment which has the same inexplicable spontaneity and self-regulation as the process of perception. Just as visual figures are co-operatively drawn against a ground by the seer and the seen, so, within their field, organism and environment are understood to be in a constant natural dialogue, and ongoing series of "creative adjustments" which make man at home in his body, his community, his natural habitat.[1]
>
> (2) One of Goodman's most distinctive and refreshing traits as a social critic is his irksome habit of arguing issues ad hominem--a characteristic which draws strongly on his experience as a Gestalt therapist. . . .
>
> The significance of the "contextual method of argument," as the Gestaltists call it, is that it short-circuits a deal of intellectual banter that may be totally beside the point and at once personalizes the debate--though perhaps painfully. It is a mode of intellectuality which brings into play the nonintellective substructure of thought and action. Goodman explains the technique in this way:
>
> " . . . a merely 'scientific' refutation by adducing contrary evidence is pointless, for the opponent does not experience that evidence with its proper weight. . . . Then the only useful method of argument is to bring into the picture the total context of the problem, including the conditions of experiencing it, the social milieu and the personal 'defenses' of the observer. That is, to subject the opinion and his holding of it to a gestalt-analysis. . . . We are sensible that this is a development of the argument ad hominem, only much more offensive, for we not only call our opponent a rascal and therefore in error, but we also charitably assist him to mend his ways!"[2]

Lines (1-20)--The statements in the first paragraph project a contextualist hypothesis because of the emphasis on intuited wholes. "There is . . . the mystical 'wholism' which the therapy inherits from Gestalt theories of perception" (5-6). This reference to "wholism" in contextual terms is a reference to the fusion of individual textures which form a whole quality. Pepper refers to cases where there is a high degree of fusion.

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[1] Ibid., p. 187.

[2] Ibid., p. 191. Roszak quotes this material from Perls, Hefferline, and Goodman, Gestalt Therapy (New York: Delta Books, 1951), p. 243.

> Where fusion occurs, the qualities of the details are completely merged in the quality of the whole. . . . Occasionally . . . an event is completely fused, as in a mystic experience or an aesthetic seizure.[1]

There is, too, a distinction made between textures ("collaboration between the perceiver and the perceived," 10-11) and qualities ("patterned wholes," 9).

Lines (21-43)--The second paragraph from Roszak clearly projects a contextual position by emphasizing the importance of context in the act of argument. This is most clearly brought out in the following statement. "The only useful method of argument is to bring into the picture the total context of the problem, including the conditions of experiencing it, the social milieu and the personal 'defenses' of the observer" (34-38).

The last quotation, from Hesse's Siddartha, is included because it implies a contextual conception of time and the "spread" of an event. Aged and wise Siddartha is speaking to an old friend, Govinda:

> "When the Illustrious Buddha taught about the world, he had to divide it into Sansara and Nirvana, into illusion and truth, into suffering and salvation. One cannot do otherwise, there is no other method for those who teach. But the world itself, being in and around us, is never one-sided. Never is a man or a deed wholly Sansara or wholly Nirvana; never is a man wholly a saint or a sinner. This only seems so because we suffer the illusion that time is something real. Time is not real, Govinda. I have realized this repeatedly. And if time is not real, then the dividing line that seems to lie between this world and eternity, between suffering and bliss, between good and evil, is also an illusion."

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[1] Pepper, World Hypotheses, pp. 243-244.

> "How is that?" asked Govinda, puzzled.
>
> "Listen, my friend! I am a sinner and you are a sinner, but someday the sinner will be Brahma again, will someday attain Nirvana, will someday become a Buddha. Now this 'someday' is illusion; it is only a comparison. The sinner is not on the way to a Buddha-like state; he is not evolving, although our thinking cannot conceive things otherwise. No, the potential Buddha already exists in the sinner; his future is already there. The potential hidden Buddha must be recognized in him, in you, in everybody. The world, Govinda, is not imperfect or slowly evolving along a long path to perfection. No, it is perfect at every moment; every sin already carries grace within it, all small children are potential old men, all sucklings have death within them, all dying people--eternal life. It is not possible for one person to see how far another is on the way; the Buddha exists in the robber and dice player; the robber exists in the Brahmin. During deep meditation it is possible to dispel time, to see simultaneously all the past, present and future, and then everything is good, everything is perfect, everything is Brahman. Therefore, it seems to me that everything that exists is good--death as well as life, sin as well as holiness, wisdom as well as folly.[1]

The analysis of this particular passage concentrates on showing how the spread of an event is projected , which assumes a contextual concept of time. The event is being--being a sinner, Buddha, Brahma, a child, robber, etc. One of the first clues that this passage projects contextualism comes with Siddartha's assertion that time is not real (7-9). (It is fair to assume that Siddartha is denying a mechanist concept of linear time, and that linear time is what is being referred to whenever the term "time" appears in this passage.) Coupled with the "unreality" of time, the first paragraph projects the contextualist position that there are no absolutes in the universe. This is brought out in a statement such as "never is man or a deed wholly Sansara or wholly Nirvana" (5-6). This statement implies a degree of flux in the universe, and that flux is attributed to a concept of time in which there are no clear distinctions among past, present, and future.

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[1] Hermann Hesse, Siddartha (Binghamton, New York: Vail-Ballon Press, 1957), pp. 144-145.

There is an implicit denial of time in: "the sinner. . .is not evolving. . . . His future is already there" (17-21). Here, the spread of the event (being a sinner and Buddha) is evident. At any point in time there is a spread back to being a sinner and forward to being Buddha. The incorporation of past, present, and future in the whole quality of an event is typical of a contextualist concept of time. The projection of contextual time and change is most blatantly projected in Siddartha's statement that "during deep meditation it is possible to dispel time, to see simultaneously all the past, present and future, and then everything is good, everything is perfect, everything is Brahman" (30-33).

Organicism

Teilhard de Chardin's The Phenomenon of Man provides material which, intuitively, projects an organicist world hypothesis, and selected passages from that work are examined here in light of that hypothesis.

> For man to discover man and take his measure, a whole series of 'senses' have been necessary, whose gradual acquisition, as we shall show, covers and punctuates the whole history of the struggles of the mind:
>
> A sense of spatial immensity, in greatness and smallness, disarticulating and spacing out, within a sphere of indefinite radius, the orbits of the objects which press round us; . . .
>
> A sense of number, discovering the grasping unflinchingly the bewildering multitude of material or living elements involved in the slightest change in the universe; . . .

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[1] Pierre Tailhard de Chardin, The Phenomenon of Man (London: Wm. Collins Sons & Co. Ltd., 1959).

A sense, lastly, of the organic, discovering physical links and structural unity under the superficial juxtaposition of successions and collectivities.[1]

Man is unable to see himself entirely unrelated to mankind, neither is he able to see mankind unrelated to life, nor life unrelated to the universe.

. . . .

The phenomenon of man--I stress this.

This phrase is not chosen at random, but for three reasons.

First to assert that man, in nature, is a genuine fact falling (at least partially) within the scope of the requirements and methods of science;

Secondly, to make plain that of all the facts offered to our knowledge, none is more extraordinary or more illuminating;

Thirdly, to stress the special character of the Essay I am presenting.

I repeat that my only aim, and my only vantage-ground in these pages, is to try to see; that is to say, to try to develop a *homogeneous* and coherent perspective of our general extended experience of man. A *whole* which unfolds.[2]

When studied narrowly in himself by anthropologists or jurists, man is a tiny, even a shrinking, creature. His over-pronounced individuality conceals from our eyes the whole to which he belongs; as we look at him our minds incline to break nature up into pieces and to forget both its deep inter-relations and its measureless horizons: we incline to all that is bad in anthropocentrism. And it is this that still leads scientists to refuse to consider man as an object of scientific scrutiny except through his body.

The time has come to realize that an interpretation of the universe--even a positivist one--remains unsatisfying unless it covers the interior as well as the exterior of things; mind as well as matter. The true physics is that which will, one day, achieve the inclusion of man in his wholeness in a coherent picture of the world.[3]

The existence of 'system' in the world is at once obvious to every observer of nature, no matter whom.

The arrangement of the parts of the universe has always been a source of amazement to men. But this disposition proves itself more and more astonishing as, every day, our science is able to make a more precise and penetrating study of the facts. The farther and more deeply we penetrate into matter, by means of increasingly powerful methods, the more we are confounded by the interdependence of its parts.

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[1] *Ibid.*, pp. 37-38. [2] *Ibid.*, pp. 38-39. [3] *Ibid.*, p. 40.

Each element of the cosmos is positively woven from all the others: from beneath itself by the mysterious phenomenon of 'composition', which makes it subsistent through the apex of an organised whole; and from above through the influence of unities of a higher order which incorporate and dominate it for their own ends.

It is impossible to cut into this network, to isolate a portion without it becoming frayed and unravelled at all its edges.

All around us, as far as the eye can see, the universe holds together, and only one way of considering it is really possible, that is, to take it as a whole, in one piece.[1]

On the scientific plane, the quarrel between materialists and the upholders of a spiritual interpretation, between finalists and determinists, still endures. After a century of disputation each side remains in its original position and gives it adversaries solid reasons for remaining there.

So far as I understand the struggle, in which I have found myself involved, it seems to me that its prolongation depends less on the difficulty that the human mind finds in reconciling certain apparent contradictions in nature--such as mechanism and liberty, or death and immorality[2]--as in the difficulty experienced by two schools of thought in finding a common ground. On the one hand the materialists insist on talking about objects as though they only consisted of external actions in transient relationships. On the other hand the upholders of a spiritual interpretation are obstinately determined not to go outside a kind of solitary introspection in which things are only looked upon as being shut in upon themselves in their 'immanent' workings. Both fight on different planes and do not meet; each only sees half the problem.

I am convinced that the two points of view require to be brought into union, and that they soon will unite in a kind of phenomenology or generalised physic in which the internal aspect of things as well as the external aspect of the world will be taken into account. Otherwise, so it seems to me, it is impossible to cover the totality of the cosmic phenomenon by one coherent explanation such as science must try to construct.

We have just described the without of matter in its connections and its measurable dimensions. Now, in order to advance still farther in the direction of man, we must extend the bases of our future edifices into the within of that same matter.

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[1] Ibid., p. 48.

[2] Teilhard de Chardin undoubtedly means "immortality" rather than "immorality."

> Things have their *within*; their 'reserve', one might say; and this appears to stand in definite *qualitative* or *quantitative* connections with the developments that science recognises in the cosmic energy. These three statements (i.e., that there is a *within*, that some connections are *qualitative*, that others are *quantitative*) are the basis of the three sections of this new chapter. To deal with them, as here I must, obliges me to overlap 'Pre-Life' and somewhat to anticipate 'Life' and 'Thought'. However, is not the peculiar difficulty of every synthesis that its end is already implicit in its beginnings?[1]

Lines (1-14)--According to Pepper the principle of organicity refers to "such a system that an alteration or removal of any element would alter every other element or even destroy the whole system."[2] This principle must be assumed when Teilhard de Chardin asserts that one of the senses which requires development for studying man must be "a sense of number, discovering and grasping unflinchingly the bewildering multitude of material or living elements involved in the slightest change in the universe" (9-11). If it is postulated that a multitude of elements will be affected by the slightest change, then there must be a concept of an interrelated system that will allow those elements to be affected when small changes occur.

The last statement (12-14) contains a reference to a concept of organic integration in terms of Pepper's categories. "Discovering physical links and structural unity under the superficial juxtaposition of successions and collectivities" (12-14) Teilhard de Chardin calls a sense of the "organic." His use of the term seems to be similar to Pepper's. As further evidence for similarity, notice that

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[1] Teilhard de Chardin, *The Phenomenon of Man*, pp. 58-59.

[2] Pepper, *World Hypotheses*, p. 300.

"superficial juxtaposition of successions and collectivities" (13-14) can be interpreted in Pepper's terms as fragments, with "links" (13) and "structural unity" (13) as nexuses connecting and integrating those fragments into an organic whole.

Lines (15-32)—The first statement (15-17) of this passage shows the stress put on "interrelatedness." In "a whole which unfolds" (32) Teilhard de Chardin's holistic approach is made explicit and provides a context for his use of "interrelatedness." This notion seems to entail, usually, the idea of "whole;" this makes it more likely that Pepper's term "integrated" and Teilhard de Chardin's term "interrelated" are used similarly. The use of the term "coherent" (31) within the context of the entire quotation (1-112) is consistent with Pepper's claim that in organicism "coherence is the positive organic relatedness of material facts."[1]

Lines (33-47)--An organicist position is projected in this passage by ". . . conceals from our eyes the whole to which he belongs . . ." (35-36), and by ". . . forget both its deep inter-relations and its measureless horizons . . ." (37-38). The last statement ("the true physics is that which will, one day, achieve the inclusion of man in his wholeness in a coherent picture of the world"--(45-47) gives at least four clues to an organicist position. Two obvious clues are the terms "wholeness" (47) and "coherent" (47). The other clues are more abstract, but no less important. First, this statement seems to hint at a theory of truth. "The true physics . . ." (45) is a physics which integrates all data in a whole and coherent way. Second, Teilhard de Chardin's contention that this system will ". . . one day . . ." (46)

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[1] Ibid., p. 310.

achieve its goal exemplifies Pepper's point that one day the goal of the ideal categories (organic whole, implicitness, transcendence, economy) will be realized, although at present the progressive categories are what we confront (fragments, nexuses, contradictions).[1]

Lines (48-68)--It is illuminating to analyze Teilhard de Chardin's metaphoric claim that "it is impossible to cut into this network, to isolate a portion without it becoming frayed and unravelled at all its edges" (63-65). Although Pepper never uses the term "network," it seems particularly appropriate to an organicist position. The principle of organicity holds that there is a system such "that an alteration or removal of any element would alter every other element or destroy the whole system."[2] By substituting key organicist terms for key terms in Teilhard de Chardin's statement, it is possible to retain substantially the same meaning. The statement becomes: "It is impossible to alter ("cut into") this organic whole ("network"), to isolate an element ("portion") without the whole ("it") becoming destroyed ("frayed and unravelled at all its edges").

Lines 69-112)--In the first part (69-88) of this final passage Teilhard de Chardin points to opposing schools of thought: materialists/spiritualists (69-70), mechanism/liberty (78), etc. Within the context of the entire passage these opposing views can be seen, in Pepper's terms, as "fragments." This analysis is supported by the phrase "reconciling certain apparent contradictions in nature . . ." (77-78).

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[1] Ibid., pp. 281-282. [2] Ibid., p. 300.

Pepper states that

> the progress of integration is not smooth and continuous, but is a buffeting of fragment against fragment, producing conflict and contradiction which is only resolved in an integration. The nexus of a fragment leads it inevitably into conflict and contradiction with other fragments.[1]

This concept of contradiction seems to be implied in Teilhard de Chardin's sentence (75-78).

The term "apparent" (77) in that sentence is also revealing. According to the organicist, in reality "there are no contradictions, for these are in absolute fact completely transcended."[2] If that is the case, then contradictions that are noticed at the present time (Teilhard de Chardin's fragments: mechanism/liberty, etc.) would necessarily have to be only "apparent" contradictions and in reality not contradictions at all.

The notion is also conveyed that the contradiction of fragments is resolved through a higher level of integration. This is strongly suggested by: "they soon will unite in a kind of phenomenology or generalized physic" (90-91). The antecedent for "they" (90) is the "two points of view," or fragments. It is here that the idea of transcendence is evident. Teilhard de Chardin's "generalized physic " (91) is a more integrated whole which transcends the contradictions of the fragments ("two points of view"). This also lends credence to our idea that the "one coherent explanation" (95) is the organicist absolute.

Teilhard de Chardin's effort to "extend the bases of our future edifices into the within (100) can be judged as an integrative step toward a more organic whole which will transcend previous apparent contradictions in nature. Finally, one of the hallmarks of the organicist position is the idea that when a more integrated whole is found, the fragments are seen to be implicit in the whole (and vice-versa). In his explication of implicitness Pepper notes that "fragments are implicit in the whole in which they are integrated."[1] With this perspective in mind, it is illuminating to look at the last statement quoted from The Phenomenon of Man: "However, it not the peculiar difficulty of every synthesis that its end is already implicit in its beginnings?" (110-112).

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[1] Ibid., p. 292. [2] Ibid., p. 305.

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[1] *Ibid.*, p. 304.

APPENDIX III

THE ANALYTICAL SCHEME

ANIMISM*

Categories and identifying features:	Comments:
A. Root Metaphor: MAN, SPIRIT	The personification of events in the universe culminates in a concept of spirit. Man is the primitive root metaphor. Spirit is the mature root metaphor.
B. Categories	
PERSONIFICATION	Non-human entities (wind, rain, trees, etc.) lead lives conforming to human or animal analogies.
CONTROLLING DEITIES and SUBORDINATE SPIRITS	Controlling and subordinate spirits are extensions of the personification of all entities and natural phenomena. Some phenomena control others (e.g., fire destroys trees) and therefore have more powerful spirits. Spirits are sometimes envisaged to be monstrous, half-human creatures.
TRANSCENDENT SPIRITS	Spirits are the "life-blood" of the objects and individuals they control. Spirits are often vaporous and have the ability to leave the object or organism which they inhabit. Spirits cause life, thought, and volition. Spirits can manifest physical power and exist after the death of the organism they inhabit.
FUTURE EXISTENCE	This follows from the transcendent nature of the spirit. After death the organism experiences a future existence.
C. Animistic truth	Truth lies in the authority of the spirit and is infallible. Greater truth is possessed by the more powerful spirit. Truth can come from the spirit's designate (shaman, medicine man, priest). A spirit's words can come from his immediate presence, dreams, voices, omens, holy books.

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*Adapted from Stephen C. Pepper's *World Hypotheses* (Berkeley: University of California Press, 1942).

MYSTICISM*

Categories and identifying features:		Comments:
A.	Root Metaphor: LOVE	Mysticism is the philosophy of love, peace, and unity. The emotion of love is the substance of the universe.
B.	Operating principles of love	
	INTENSITY	The stronger the emotion is, the greater the reality.
	FUSION	The stronger the emotion is, the greater the tendency for things to fuse and be seen as generated from love.
	INCLUSIVENESS	As the emotion becomes greater, more things are fused and there is more reality.
C.	Quality of the experience	This refers to how the experience of love is felt by the individual.
	SUPREMELY COGNITIVE	A mystical experience gives immediate knowledge and denies other modes of cognition.
	IMMEDIATE AND UNINTERPRETED	Senses and imagination are not used. The experience comes through revelation.
	CERTAIN	Cognitive certainty is intense in a mystical experience.
	EMOTIONALLY ECSTATIC	The revelation has a beatific quality.
D.	Mystical truth	Truth comes through the mystical experience. The greater the emotional experience is, the greater the truth revealed. The most intense experience reveals absolute truth.

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*Adapted from Stephen C. Pepper's *World Hypotheses* (Berkeley: University of California Press, 1942).

FORMISM[*]

Categories and identifying features:	Comments:
A. Root Metaphor: SIMILARITY	Observation of similarity gives rise to immanent and transcendent formism.
B. Immanent formism	Similar events or objects are described and the results of the description are accepted literally.
CHARACTERS	Characterization of things is in terms of quality or relation. Character, quality, and relation are all forms.
Quality	Color, size, shape, texture, luster, etc. are qualities of things.
Relation	"Side by-sideness" is a relationship between two particular things.
PARTICULARS	These are numerical entities characterized by qualities and relations. Two aspects of objects of perception are particularity and character. These two aspects are distinct but never are experienced separately.
PARTICIPATION	This is the tie between characters and particulars. It is the characterization of a particular or vice-versa. A class is a collection of particulars that participate in one or more characters. The basis for classification lies in the similarity of specimens to ideal forms.
C. Transcendent formism	The observation of similarity comes from two sources: goods made according to the same plan, and natural objects growing according to the same plan.
NORMS	A plan to make something is a norm which transcends the thing made, and natural growths develop according to a norm. In both cases, because of contingencies (available materials, skills of the artisan, natural conditions, etc.), the norm is not fully realized but transcends the material objects. Natural laws are norms which regulate the occurrences of nature. The aim of science is to discover the laws which nature "follows."
MATTER	Matter exemplifies the norms. (This category parallels the second category of immanent formism—particulars.)
PRINCIPLE OF EXEMPLIFICATION	This is the tie between norms and matter and materializes the norms. (This category parallels the third category of immanent formism—participation.)
D. Existence and subsistence	These concepts reconcile the first categories of immanent and transcendent formism. (Since the second and third categories of both types of formism are compatible, reconciliation of the first categories produces "unified" formism.) Existence refers to particulars or matter. Primary existence refers to bare particulars which have no characters and therefore cannot be perceived. Concrete existence refers to particulars with participating characters (perceivable concrete objects). Subsistence refers to characters and norms not particularized. Characters and norms are both forms and are subsistently related.
E. Correspondence theory of truth	Truth is the similarity or correspondence between two or more things, one of which is said to be true of the others.
Historical truth	Truth concerns existence and consists of describing characteristics of particular events.
Scientific truth	Truth concerns subsistence and consists of descriptions of norms and laws. It is arrived at by induction.
Empirical uniformities	Empirical uniformities are half-way between contingent fact and necessary law. They do not show the necessity for regularities and therefore are not completely scientific.
Natural laws	Regularities necessarily follow from natural laws.

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[*] Adapted from Stephen C. Pepper's *World Hypotheses* (Berkeley: University of California Press, 1942).

MECHANISM[*]

Categories and identifying features:	Comments:
A. Root Metaphor: MACHINE	Discrete mechanism accounts for the mechanics of a watch. Consolidated mechanism accounts for a dynamo.
B. Primary categories	Primary categories describe the way a machine works and give insight into its reality. (Primary categories below are treated according to discrete and consolidated mechanism.)
1. Discrete mechanism	Structural features of the universe are distinct (e.g., space, time, mass, number, motion, etc. are unrelated concepts). Action is by contact. Because all structures in the universe are independent, anything could have been otherwise. The universe accidentally is as it is. However, once the structures are given events inexorably follow. Statistical laws are not really laws, but are approximations to reality.
FIELD OF LOCATION	Parts of a machine must have spatial location for the machine to work. An exact description of a machine specifies the location of the parts. Things are real by virtue of a location. Nothing exists without a location in space and time.
PRIMARY QUALITIES	These refer to quantifiable aspects relevant to the efficient functions of a machine. Primary qualities ultimately reduce to differentiating qualities of particles distributed in time and space (size, shape, motion, solidity, mass, and number).
PRIMARY LAWS	These laws (e.g., F=MA) determine the configuration of elementary particles in time and space.
2. Consolidated mechanism	Recent advances in physics (especially relativity theory) collapse a number of discrete mechanistic categories. Action can be at a distance. There are no statistical laws. The universe is completely determined since the only existing particular is the spatiotemporal-gravitational-electromagnetic field.
FIELD OF LOCATION	The field of location is the spatiotemporal field.
PRIMARY QUALITIES	Mass is the only differentiating quality. General relativity theory consolidates the gravitational field (a phenomenon of mass) with the spatiotemporal field. The electromagnetic field law (involving the qualities of electric charge and magnetic attraction) operate in the spatiotemporal field.
PRIMARY LAWS	Descriptive laws are shorthand for structural modifications of the consolidated spatiotemporal-gravitational-electromagnetic field (the only existing particular).
C. Secondary categories	These refer to qualities that have no bearing on a machine's operation. The descriptive reality of a machine (lying in the primary categories) is inferred from secondary categories (human perception is of secondary qualities). Mechanistic reductionism is the explanation of secondary qualities in terms of primary categories (e.g., explaining mental events in terms of physiological processes).
SECONDARY QUALITIES	These are aspects of the machine perceived by individuals (e.g., color, texture, odor, sound, etc.).
PRINCIPLES OF CONNECTION	These elucidate the relationship between secondary qualities and primary categories. Three theories about the connection between primary and secondary categories are identity, causation, and correlation.
SECONDARY LAWS	These laws show the regularity of the relationships among secondary qualities. Laws of association in human psychology can be considered secondary laws.
D. Causal-adjustment theory of truth	Statements are manifestations of physiological responses to stimuli. Truth is adjustment of physiological attitudes to the organism's environment and is ultimately explained by causal relationships among primary qualities. In discrete mechanism the nature of adjustment seems to imply a correspondence theory of truth. Consolidated mechanism seems to imply a pragmatic theory of truth.

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[*] Adapted from Stephen C. Pepper's *World Hypotheses* (Berkeley: University of California Press, 1942)

CONTEXTUALISM*

Categories and identifying features:	Comments:
A. Root Metaphor: HISTORIC EVENT	The historic event is the active, present event and its context and is characterized by verbs (seeing, doing, being, teaching, etc.). Contextual categories are derived from the intuited quality of the historic event. Reality is not inferred.
B. Basic categories: CHANGE, NOVELTY	Contextualism denies absolute structures or inherent order in the universe. Change and novelty are basic to this hypothesis.
C. Categories of this epoch	Quality and texture are categories that account for order in the present epoch.
QUALITY	Quality is the intuited wholeness or total character of an event.
Spread	Every present event has connections with the past and future. A present event has spread and is not a point on a dimensional time scale.
Change	Qualities of events change according to perspectives from which they are viewed.
Fusion	Textures coalesce to form a quality. Individual textures are difficult to discern in highly fused events.
TEXTURE	Texture refers to the elements that make up qualities. Textures also exhibit qualities and are made of strands lying in a context. No analysis of an event leads to absolute reality. The results of analysis depend on context.
Strand	A strand is whatever contributes directly to the quality of a texture. Strands can be seen in terms of purposes or goals.
Context	Context is whatever contributes indirectly to the quality of a texture.
Reference	This subcategory is discussed in terms of initiation, direction, and satisfaction of a strand. If strands are taken as purposive behavior, observation of an action will note the initiation of the action, the goal of the action, and the satisfaction of the goal. Linear references consist of a single initiation and proceed directly to a satisfaction. Convergent references consist of several initiations converging upon one satisfaction, or one initiation culminating in several satisfactions. Blocked references are those in which no satisfaction of a strand is reached. Instrumental references involve actions which are intended to relieve a blocked reference and which permit a strand to reach satisfaction.
D. Schemes (formulas, diagrams, etc.)	These are instruments which do not reveal reality but are considered useful for prediction, explanation, and control.
E. Operational theory of truth	Truth is in the context of human action.
Successful working	Truth is successful action. Those actions which are successful, in terms of their goals, are true. Truth does not give insight into the textures and qualities of nature.
Verified hypothesis	Truth lies in the hypothesis that leads to a successful act. Truth does not give insight into the textures and qualities of nature.
Qualitative confirmation	Truth lies in the hypothesis that leads to a successful act. Truth does give some insight into the textures and qualities of nature.

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*Adapted from Stephen C. Pepper's *World Hypotheses* (Berkeley: University of California Press, 1942).

ORGANICISM*

Categories and identifying features:	Comments:
A. Root Metaphor: INTEGRATION	Events and processes are seen to be integrated to varying degrees.
B. Categories	
FRAGMENTS	Fragments refer to experience. An isolated datum is a fragment. Experience is no longer fragmented when seen as integrated in a coherent whole.
NEXUSES	Nexuses are connections among fragments and imply larger, more coherent, integrated wholes.
CONTRADICTIONS	Contradictions occur when the nexuses of an experience lead to conflicting experiences. The conflict can be resolved by a higher level of integration.
ORGANIC WHOLE	The absolute organic whole is approached when all experience is found to be successively integrated into larger and more coherent wholes. The Absolute is the ultimate integration and most coherent organic whole. As the Absolute is approached, the system becomes more inclusive, more determinate, and more integrated. There is no change: therefore, time is not real.
IMPLICITNESS	When an organic whole is reached, the fragments that led to its development are seen to be implicit in the whole.
TRANSCENDENCE	The contradictions of fragments are res[illegible]ded when an organic whole is reached.
ECONOMY	All experiences are valid (and are econ[illegible], when an organic whole is reached.
C. Coherence theory of truth	There are degrees of truth in relation to the amount of fact obtained. More truth is revealed when there is higher integration of facts. The criteria of truth are the categorial features of the organic whole–inclusiveness, determinateness, and organicity. Truth includes formal consistency but is more than that. It is the positive relatedness of material facts to produce a coherent whole. Accurate predictions are considered evidence for the truth of the organization of the data that produced the predictions.

*Adapted from Stephen C. Pepper's *World Hypotheses* (Berkeley: University of California Press, 1942).

APPENDIX IV

THE ANALYSIS

Chapter One

"Life and the Universe"[1]

1L1-25[2] ("CHARACTERISTICS OF LIVING THINGS")

Overview

Formism is projected because of the assumption of the root metaphor (similarity) in making generalizations about the characteristics of living things. The section provides a context for viewing the ensuing subsections. Movement, irritability, reproduction, metabolism, etc. are similar qualities that allow certain entities to be characterized and classified as "different from" or "similar to" other entities.

It is important to point out the implication that generalizations are being made about large numbers of entities (e.g., "all matter in the universe," "living things"). This helps provide a context for interpreting generalizations throughout the textbook. Claims are usually made not about just one organism, but about "the organization and structure of living things" (1L22-23).

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[1] Chapter numbers and titles in this analysis refer to Speed's General Biology (see Appendix V).

[2] Page numbers in the code (e.g., page 1 in 1L1-25) refer to the page numbers of General Biology rather than the page numbers of Appendix V. Except for the title page of chapters, the page numbers are found in the upper right or upper left corner of General Biology. The reproduced pages of General Biology also are paginated according to their place in Appendix V of this thesis. These page numbers (A169, e.g.) are centered at the top of each reproduced page of General Biology.

1R40-2L20 ("Movement in most animals. . .")

Analysis

This section provides an example of the projection of mechanism because of the effort to specify the location of the effective parts of organisms. This can be seen, for example, in the explanation of movement in a worm: "Movement of a locomotory kind is achieved by the dew worm as a result of contraction of the fibers in outer circular muscles and inner, longitudinal ones and by means of muscles attached to bristle-like limbs called setae" (2L12-17). There is clearly an effort in this statement to locate the position of the parts of the worm that cause movement. This corresponds to one of the distinguishing features of mechanism--that the exact description of a machine requires the specification of the location of effective parts.

4L4-4R5 ("Fish have developed. . .")

Analysis

The paragraph describing the movement of fish (4L4-20) projects mechanism because the explanation of movement assumes action-by-contact. Mechanism is also projected because of the effort to show the location of those parts of a fish responsible for particular motions. "Force exerted by the myotomes on either side of the semi-rigid vertebral column causes the body to undulate" (4L9-11) is an example of locating a cause of action which ultimately is explained within the action-by-contact paradigm.

The statement "the musculature of the limbs of amphibians and terrestrial vertebrates such as lizards, birds, and mammals follows a similar pattern where the operation and attachment of muscles are concerned" (4R1-5) projects both formism and mechanism. It projects formism in the phrase "the musculature. . . follows a similar pattern" (4R1-4) because of the explicit reference to similarity and plan. (An identifying feature of transcendent formism is the observation of natural objects which grow according to a similar plan.)

The phrase "follows a similar pattern where the operation and attachment of muscles are concerned" (4R3-5) projects mechanism because of the context of the previous two paragraphs (4L4-30), because of the terms "operation" and "attachment," and because of what "similar" refers to. The analysis of the previous two paragraphs (4L4-30) showed the projection of mechanism because of reference to location and action-by-contact. The term "similar" refers again to those paragraphs, and "operation" implicitly refers to the same kind of action-by-contact as previously described. "Attachment" refers to the location of the muscles (effective parts of a machine).

5L3-15 ("Plants generally react. . .")

Analysis

Mechanism is projected because action-by-contact is assumed, because the action is quantified in the description, and because there is an attempt to locate the effective parts of a machine. Action-by-contact is assumed in ". . .will fold its leaves. . . after they have been touched by an object" (5L9-11). The statement that the action will take place "a second or two" (5L10) after contact projects mechanism because there is an attempt to quantify (on a linear time scale) the lapse between contact and action. Furthermore, it is implied that during the time lapse some mechanism (change in water pressure) takes place that causes the action. The statement that the change in water pressure takes place within cells (5L14-15) is an attempt to locate the effective parts of the machine and, consequently, projects mechanism.

5R9-28 ("METABOLISM")

Overview

This section projects mechanism and formism. Chapters 6 and 7 must be considered as part of the context in which statements in this section are to be read. The emphasis on mechanisms which depend on unobservable particles, quantification, and the precise location of various reactions indicates the projection of a mechanistic world hypothesis in Chapters 6 and 7.

Analysis

Formism is projected because metabolism is considered a similarity among living things. This is brought out in the statement "all living things exhibit metabolism" (5R12). Mechanism is assumed because the concept of metabolism "refers to the sum total of all the physical and chemical changes which take place within an organism" (5R13-15). This is mechanistic reductionism in which perceivable qualities (e.g., that something is living) are explained in terms of unobservable processes involving particles.

7L1-54 ("INTERSTELLAR SPACE")

Overview

This section is judged to project a mechanistic hypothesis because of the emphasis on the discrete and particulate nature of interstellar space and because quantification plays an important role in the description of space. This section is important because it provides a context for discussion in the rest of the textbook. The context is that of a physical universe in which biological phenomena are found. And, as will be seen shortly, the projection of mechanism is evident in Chapter 2 where aspects of molecular theory are presented as a background for discussing chemical reactions regarded as essential to describing biological phenomena. This section is context then, for the idea that the same principles used to describe the physical universe can be used to describe the biological universe.

Analysis

A mechanistic world hypothesis is projected in part because particles are spoken of as being discrete. For example, the idea of discrete entities is implied in the statement that "distances thousands of times greater than that separating us from the sun separate these stars from each other" (7L9-11). The phrase "the space between stars" (7L13-14) also projects the notion of discreteness. These statements and phrases lend themselves to an analysis in terms of primary qualities of discrete mechanism (discrete particles distributed in space and time). The idea of discrete particles is again projected by a statement about the remote chance of collisions among them (7L21-25).

A mechanistic world hypothesis is also projected because quantification is an important aspect of the description of interstellar space in this section. Distances, for example, are quantified in terms of light years (7L37-44) and age is quantified on a linear time scale (7L46-54).

Chapter Two

"The Organization of Molecules"

11L1-12L36 ("INTRODUCTION")

Analysis

Three world hypotheses are projected in this section: mechanism, formism, and organicism. Formism is projected because of the attitude toward natural laws. Organicism is projected because of the way a contradiction in nature is discussed. A mechanist world hypothesis is projected (11L1-11) because there is an attempt to describe an aspect of life (its occurrence) in terms of inferred particles (complex molecules). The point is further supported in the next section (12L37-P18), which explains the reactions among particles. And, of course, it must be seen in the context of the statement that "the rearrangement of atoms of matter is another characteristic of life" (11R8-9).

There are several statements to which an organicist framework is applicable--for example, "and so began a process that appears to defy the Second Law of Thermodynamics" (11L11-13). What has been noticed, in organicist terms, is an apparent contradiction--that living organisms "appear" not to operate according to a law of nature. Later it is claimed that "living things thus exist in a decaying physical universe and, like this universe, obey the thermodynamic laws" (12L14-16). A resolution of the apparent contradiction is offered in an implied model of two universes (organic and inorganic), one of which becomes more complex at the expense of the other (12L16-20). This position, and the implication that the original contradiction was only apparent and in reality not a contradiction at all, is indicative of an organicist world hypothesis and is reinforced in the remaining statements of the section (12L21-36).

A formist world hypothesis is also projected in this section. In formism natural laws are seen as forms which nature necessarily follows. This position is implied in the statement that "living things thus exist in a decaying physical universe and, like this universe, obey the thermodynamic laws" (12L14-16). "Obey" is the clue.

Comment

It is appropriate to look more closely at some judgments made in the analysis of this section. It is useful to do so at this particular time because these issues occur throughout the analysis. As an example, we can look at the judgment that a mechanistic world hypothesis is projected by statements in 11L1-11. The issue concerns the intuitive nature of the judgment. The claim is that these statements project mechanism. It is important to realize, however, that this is not the only analytical judgment which could result from an examination of the statements. The issue is a fundamental one.

Each world hypothesis, by its very nature, makes a claim to be able to interpret all phenomena in the universe. Therefore, there is nothing in the statements requiring one to make the judgment that only mechanism is projected. The categories of contextualism could also be applied to these statements (elementary particles, then, are seen as textures that make up the intuited "real" whole). Again, formist categories could be applied (elementary particles, then, are seen as forms). Yet again, organicist categories would stress the interrelatedness of the particles and their progressive development toward higher forms of existence (life). Therefore, nothing is stated in 11L1-11 that could not be construed as contextualism, formism, or organicism. As noted earlier, this is the case because an adequate (Pepper's technical term) world hypothesis can account for all phenomena.

The reason for judging 11L1-11 as projecting mechanism and not some other world hypothesis involves three issues. The first is settled by a convention adopted in Chapter V for the analysis: logically primitive characteristics of a world hypothesis take precedence in judgments about projection. In this case, explanation of observable phenomena in terms of reduction to unobservable, discrete particles is a logically primitive characteristic of mechanism. Thus, in spite of the possibility that contextualism, formism, or organicism could also account for statements 11L1-11, as demonstrated above, mechanism takes precedence.

Related to this point is the consideration that, while all world hypotheses claim to be able to interpret all phenomena, it seems intuitively clear that some world hypotheses interpret some phenomena more easily than do others (which could be one reason Pepper found different examples convenient in explicating each hypothesis). In terms of statements 11L1-11, for example, a mechanistic world hypothesis seems intuitively correct when examining the cause of things. When we look for a cause, we commonly seek an explanation in terms of an action-by-contact paradigm epitomized by Newtonian physics. This example (11L1-11) concerns causality even though it is not explicitly expressed that way. A cause of life is looked for in terms of particles (molecules).

A final issue concerns the probable context in which statements are understood. We might assume, for example, that in Western society things (tables, chairs, particles) are intuited as being discrete--normally, things are not intuited as being complexly interrelated. This provides context for judging the projection of mechanism because of the discreteness of particles. It can be called cultural context. Context within the textbook also influences a judgment, however. For example, the notion of discrete particles is especially prevalent in the discussion of interstellar space (7L1-54). In the absence of any attempt to tell the student otherwise, then, we can reasonably assume that when particles (atoms, molecules, stars) are discussed, they will be interpreted in a discrete mechanistic sense (to be like tables and chairs). This cultural context carries over to the analysis of the example (11L1-11) and helps provide the basis for the judgment that mechanism is projected. It should be stressed, however, that no absolute claim is made in such judgments--only a provisional probability claim.

12L37-R27 ("INORGANIC SUBSTANCES")

Overview

The analysis of this section shows the projection of both mechanistic and contextualist world hypotheses. It is worthwhile to notice an abrupt shift in projection in this section. For the most part mechanism is projected until the explicit discussion of the "reality status" of unobservable entities, which projects contextualism. Within a mechanistic framework these entities are accorded the status of being real; within a contextualist framework their status is related to their usefulness.

Analysis

The claim that "all matter in the universe, including the substance of living things, is composed of 88 naturally-occurring atoms. . ." (12L38-43) projects a mechanistic world hypothesis because the description of matter is in terms of discrete atomic particles. This description includes "the substance of living things" (12L38-39). Further description of matter includes the explanation of chemical reactions according to the interactions of particles: e.g., "the driving force behind all chemical reactions. . . ." (12R14-18). These statements imply that descriptions of matter reside in primary mechanistic qualities (atoms, molecules, electrons, etc.) which are inferred from the observable secondary mechanistic qualities.

A contextualist world hypothesis is projected in the second analyzed paragraph (12R19-27) because of the attitude taken toward diagrams and models. It is illuminating to analyze each statement separately. "No one knows what an atom or an electron looks like" (12R19-20) is consistent with the mechanistic treatment projected in the previous statements of this section. That is, the descriptive reality of matter lies in the interactions of unobservable particles. The next statement claims that diagrams of atoms are "unreal" (12R20-22). This statement projects a contextualist world hypothesis in the sense that schemes (maps, diagrams, formulas, etc.) make no claim to reality but are instruments *useful* for predicting, controlling, and explaining. The next statement (12R22-27) supports this analysis by stating that even though the diagrams make no claim to reality, they are useful for explanation ("enable us to discuss simple chemical reactions").

17L1-R13 ("When carbon combines. . .")

Overview

The analysis in this section corroborates the analysis of section 12L37-R19 in which a mechanistic world hypothesis is projected. That section contains two main assertions: (1) that all matter is made of particles, and (2) that chemical reactions involve interactions among those particles. This section (17L1-R13) provides a detailed example of the reactions between hydrogen and carbon which are major components of organic molecules. Later (pp. A73-A74) the analyses of these two sections (12L37-R19 and 17L1-R13) is compared with section 28L16-30L14.

Analysis

The statements in 17L1-29 project mechanism because observable reactions are explained in terms of elementary particles. The explanation is of the chemical reaction between hydrogen and carbon, and chlorine and carbon. These atoms are easily construed as particles existing in time and space and are inferred from the secondary categories of a mechanistic world hypothesis. It should be remembered that in 12R20-22 (". . .the diagrams of atoms which appear in this and other texts are unreal") there was some suggestion of a contextualist view of these inferred entities. In spite of that earlier, tentative judgment (pp. A65-A66), the claim of "unreality" seems to be about the diagrams, not about the entities themselves. In that case it would be plausible to say that a reasonable interpretation of the statement is that the inferred entities are real. Consequently, a mechanistic world hypothesis is judged to be projected. This judgment is supported by the statements "all matter in the universe, including the substance of living things, is composed of naturally-occurring atoms. . ." (12L38-40) and "of the naturally-occurring elements in the universe only a dozen or so make up to any great extent the substance of living matter" (17R3-6). Both of these statements yield readily to the categories of mechanism, but neither provides much evidence for a contextualist interpretation.

Comment

A statement that "all matter is composed of atoms" implies the existence and, consequently, the reality of atoms. (At least, it does so in the absence of any attempt to tell the student otherwise, as noted on p. A64.) This is consistent with a mechanistic world hypothesis, but not with a contextualist one which emphasizes "usefulness" rather than "reality."

21R17-26 ("This enormous variation. . .")

Overview

It is worthwhile to call attention to yet another way in which a mechanistic world hypothesis can be projected. In the mechanistic world hypothesis primary qualities are described according to quantifiable aspects (size, shape, motion, solidity, mass, number). Consequently, quantification assumes an important role in the mechanistic categories and is an identifying characteristic. In the statements of this section quantification assumes an important role in the explanation of variability.

Analysis

A mechanistic world hypothesis is projected in these statements (21R17-26) for two reasons. First, mechanism is projected because variation in organisms (an observed quality) is explained by reference to inferred entities (proteins made of amino acids). It is a mechanistic reductionism in which observed qualities are explained in terms of discrete particles existing in time and space. Second, mechanism is projected because quantification is the vehicle for helping the reader understand the enormity of the variation. Quantification, of course, occurs at two levels. The first level is the substantive quantification of the particles involved in producing the variation ("variation in the form of proteins composed of just 20 types of amino acid"). Second is the non-substantive quantification involved in the comparative example ("hundreds of thousands of words formed from the 26 letters in the English alphabet").

Comment

The meta-messages given to students in the form of metaphors, analogies, examples, comparisons, etc. may not be trivial and are worth serious consideration. In this section the meta-message takes the form of "something is better understood (or more easily understood) if it is quantified." This is judged to project an aspect of mechanism even though the quantification might lie within non-substantive pedagogical metaphors, analogies, and so on.

Chapter Three

"The Organization of Life"

22L1-R9 ("THE ORIGIN OF LIFE")

Overview

This section projects mechanism because of the attempt to explain a phenomenon (origin of life) in terms of the interactions among discrete particles (atoms, molecules, amino acids). The last few statements analyzed (22L29-R9) reveal some interesting features related to context and will be discussed in more detail in the "Comments."

Analysis

In the statements of the second paragraph (22L9-36) a mechanistic world hypothesis is projected because the explanation for the origin of life is based on interactions among inferred particles. A mechanism for these interactions has already been presented to the students (Chapter 2--"The Organization of Molecules"--pp. 11-21) and consequently serves as the context for a statement like "lightning flashes and ultra-violet light from the sun would possess sufficient energy to break the chemical bonds of water vapor. . .and in doing so would create simple amino acid molecules" (22L13-17). The creation of simple amino acid molecules, then, occurs through a means presented earlier in Chapter 2.

A second way in which mechanism is projected is through the assumption of action-by-contact in the statement "many such acids were washed down into the seas" (22L18-19). This assumes an action-by-contact paradigm (water moves particles) to explain how the acids get into the sea.

Finally, several additional statements in this section contribute to the projection of mechanism: "then would have come the final step--the formation, by chance, of a nucleoprotein molecule . . ." (22L29-32); "if the reader finds that this chance assembly of all the constituents of living cells strains his or her imagination, it must be remembered that all this took place over a billion or so years" (22L37-R1); "given enough time anything can happen by chance" (22R2-3); ". . . random collisions between amino acids and these building materials would be bound to cause some reaction" (22R7-9). The common elements running through these statements are randomness and chance. The assertion that the collisions among particles occurs randomly and by chance supports the mechanist's intuition of particles located in space and time.

Comment

It is useful to look more closely at "chance" as it is used in these passages because it shows the influence of external context (context outside the textbook).

We can begin by considering what the analysis would reveal if external context were not an issue. The claim for the projection of mechanism could still be made because of the explanation of events in terms of discrete particles. However, the chance occurrence of events in the universe, not guided by any order, is consistent with contextualism, the only world hypothesis that denies absolute structures or inherent order in the universe. Yet something suggests that a claim for the projection of contextualism is inappropriate here. The problem seems to be resolved if external context is considered. Chance is used, in discussions of evolution, usually in contrast to any notion of purpose, life-force, divine will or divine guidance. There does not appear to be anything in Pepper's categories of mechanism that allows one to say that the use of the term chance assumes a mechanistic world hypothesis. However, given the polarity between chance and terms like guidance, special creation, life-force, etc., it is probably the case that mechanism is the only world hypothesis that definitely denies or explains away guidance or life-force" In formism, variations on the theme of life-force, for example, can be interpreted as forms which nature follows.[1] The mere fact that contextualism denies absolute structures in the universe precludes the possibility of denying constructs like life-force. In organicism notions of life-force are seen in terms of integrative goal-oriented processes aimed at some ultimate goal (as seen in the preliminary analysis of some of Teilhard de Chardin's writing--pp. A40-A47). Animism, of course, insists on concepts such as life-force. Nor is there anything in the mystical categories to prevent the manifestation of creation, life-forces, guidance and so on. Thus mechanism is the only hypothesis that insists on the reduction of these concepts to interactions among discrete particles. The historical context of mechanism vs. animism (vitalism) in biology lends further credibility to the claim that statements involving chance project mechanism.

Before completing the analysis of this section, it is appropriate to examine the statement "As Charles Darwin put it, 'given enough time . . ." (22R1-2). This is a clear use of authority to lend credence to a point being made.

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[1] A most interesting exposition of this point is found in F.L. Kunz, "The Role of a Biological Field Theory in Education," Main Currents in Modern Thought, VIII (March, 1951), pp. 9-13.

The quote is an unsubstantiated assertion. It would be a tenuous claim to say such use of authority projects animism. Yet, an animistic world hypothesis does give full recognition to authority, and at least the meta-message projected in this statement is that that kind of use of authority (authority without argument) is appropriate.

23L1-21 ("Methane gas from a burner. . .")

Analysis

The analysis of this section focuses on the projection of mechanism due to quantifying aspects of the description of the experiment: "six-inch spark;" "eight-volt, three-amp supply;" "450,000 volt arc;" "maintained for a week" (23L8-12). There is nothing that precedes or follows this section that requires a quantified account. In the absence of some other reason for quantifying this description, one rationale for making the description quantitative is that it provides a more real description of the experiment. Another rationale, of course, is that of faithful reporting. In either case, a mechanistic world hypothesis is projected.

23L26-R29 ("Once self-replicating nucleoproteins. . .")

Analysis

This section shows the projection of mechanism and organicism. A mechanistic world hypothesis is projected because a plausible explanation for the origin of life is in terms of discrete particles (nucleoproteins, molecules, and amino acids). "Random chemical nutrition" (23R6-7) is judged to project mechanism because of the assumption of discrete particles and because of "chance," as discussed in the analysis of section 22L9-R9 (pp. A70-A71).

However, there also seem to be traces of the projection of an organicist world hypothesis. This first occurs with the statement that "it became possible for more complicated reactions and associations to take place, which resulted in living chemical systems" (23L37-R2). "Associations" and "systems" imply, to a degree at least, some form of interdependence or integration, concepts which have their roots in an organicist world hypothesis. An organicist view also seems to be projected with the phrase "the organized form of nutrition we know today" (23R7-8). This is a deliberate contrast with "random chemical nutrition" (23R6-7).

28L16-30L14 ("MULTICELLULAR ORGANISMS")

Overview

The analysis of this section reveals the projection of elements of either organicism or contextualism and is to be contrasted with the earlier analysis of section 17L1-R13 (pp. A66-A67). There it was shown that mechanism is projected in statements about the particulate nature of matter and the mechanisms involved in chemical reactions. Generally, mechanism was judged there to be projected because of the explanation of an observable phenomenon (life) in terms of interactions of discrete particles.

Analysis

The emphasis on "wholes" in "aggregation of small particles into wholes appears to be a common phenomenon in nature" (28L17-19) projects either contextualism or organicism since both of these world hypotheses are holistic. The projection of organicism is probably more reasonable, however, since the use of "wholes" in the statement (28L17-19) does not seem to refer to a contextually intuited wholeness of an event. Rather, it seems to refer to a more integrated, more coherent whole as is categorized in organicism.

What is interesting, however, is to contrast the statement that "cell aggregation is far too complex to be explained simply as gravitational or electrical attraction of particles" (28L27-30) with previous statements which project a mechanistic interpretation of the origin of life. Here, the mechanistic interpretation is denied and a more organicist interpretation (with the intuition of complex integration) is projected.

The explication of a trend toward successively higher levels of complexity and interdependence in organisms can most easily be analyzed with the integrative categories of organicism. Therefore, the statement that "as cells became more specialized in function they lost their ability to live independently of the organism itself" (28R27-30) is judged to project organicism. The dependence of cells on the whole organism assumes some degree of integration. Organicism is again projected in the statement that "there is little point in specialization of structure if such specialized cells are not organized as a whole to perform their functions" (30L6-9).

32R6-29 ("Coordination")

Analysis

Lying in the context of the above analysis, this section projects an organicist world hypothesis because some form of integrated system is assumed when making a statement like that in 32R6-14. "System" and "coordination" are the primary clues here.

Chapter Four

"The Anatomy of the Cell"

35L1-37L54 ("INTRODUCTION")

Overview

The contents of this section need to be analyzed in light of the discussion in the remainder of the chapter. Therefore it is appropriate to sketch roughly some relevant features of the chapter. Much discussion of the anatomy of a cell projects a mechanistic reductionism because cell structures (cell membrane, cell walls, ribosomes, etc.) are described in terms of discrete particles (molecules). This is shown, for example, in the statement that "one of the most impressive things about the cell is the concentration within it of extremely complex molecules" (39R13-15), for "although the smallest known bodies in the cell, ribosomes, are in fact giant molecules with molecular weights in the region of 4,000,000, compared with water, which has a molecular weight of 18" (42R44-49). It is on the basis of such statements that the analysis of this section is revealing.

Analysis

The analysis of this section focuses on the claim that "unfortunately, Swammerdam became convinced that his studies of these hitherto invisible forms of life were uncovering the secrets of life known only to the Creator and he burned all his sketches and destroyed his microscopes" (35L20-26). Lying in the context of following statements, this statement is anti-animistic. It is so because of the negative value attached to the term "unfortunately" and because use of the term "Creator" implies an animistic world hypothesis. In the following passages it is clear that the kind of investigations which Swammerdam pioneered (microscopic examination of cell detail) has become an acceptable paradigm for investigation of the cell.

For example, there is the implicit message that better understanding of the cell can be had by reducing the examination of the cell to component particles. Two statements are primarily responsible for this implication: (1) "scientists, limited in their understanding of cells by a maximum magnification of 2000 diameters . . . were now in possession of a tool that raised the limits of magnification to one million diameters" (37L7-12); and (2) "at this magnification the cells would be as large as classrooms and even some of the molecular structure of the cell would be revealed" (37L23-26).

(This last statement provides a clue to the projection of mechanism rather than contextualism since it would be consistent only with mechanism to speak of "revealing" something. The implication of that term is that there is something there (existent) to be revealed. This is consistent with the status of reality accorded inferred entities in a mechanistic world hypothesis. This analysis is further supported in 37L30-32 with the statement that "now, instead of guessing the structure of the smaller cell bodies, biologists can examine them in fine detail.")

Another way in which a mechanistic world hypothesis is projected lies in the example (37L13-23). There quantification in terms of size assumes an important role in an attempt to provide the student with examples to understand the importance of the microscope. It has already been mentioned in the analysis of 21R17-26 (pp. A67-A69) that pedagogical devices such as metaphors, examples, etc. might provide strong messages about appropriate ways of viewing phenomena.

Comment

It is useful to make a distinction between non-projection of a world hypothesis and anti-projection. A section non-projects if it projects nothing with regard to a particular world hypothesis. A section anti-projects a world hypothesis if, overtly or by context, it is stated that this world hypothesis is in some way inadequate for interpreting phenomena.

39R4-24 ("CELL STRUCTURES")

Analysis

Formism is projected in the statement "it is possible to explain the anatomy of the cell by including these structures that appear in most animal and plant cells" (39R9-12). This is so because the reference is to similar characteristics. The statement in the second paragraph of this section (39R13-24) projects mechanism primarily by reducing the description of cell structures to reactions among particles.

40L14-26 ("Both animal membranes. . .")

Overview

It is revealing to analyze some sections in light of analyses of other sections that deal with similar topics. The analysis of this section shows the possibility of the projection of organicism. To appreciate that possibility, it is necessary to look at the treatment given osmosis (not analyzed, but see below), and also to consider the context of an earlier section (pp. A73-A74) titled "SPECIALIZATION OF STRUCTURE AND FUNCTION OF ORGANISMS" (28R11-30).

The treatment of osmosis in section 44R1-8 (not analyzed) and in a subsequent chapter (pp. 60-63) is mechanistic.[1] The explanation of of osmosis depends on the treatment of diffusion (p. 59), which is in terms of the random motions of particles (usually molecules). Therefore, the statement that "because the concentration of water is lower within amebae [sic] due to the presence of organic and other materials, there is a tendency for water molecules to diffuse into the cell from a region of higher concentration of water" (44R1-6) is judged to project mechanism.

Relevant to this analysis is the analysis of 28R27-30 (p. A74), which showed the projection of organicism because of the implication of integration and interdependence.

Analysis

In light of these considerations it is interesting to analyze 40L14-26. The statement that "both animal membranes and cell membranes are composed of molecules of fat and protein" (40L14-16) projects mechanism because the description is in terms of particles. The discussion of differentially perm[illegible] membranes (40L16-26) could, however, possibly project either mechanism or organicism. It projects mechanism because it implies an even more complicated "mechanism" than is found in ordinary diffusion and osmotic processes. On the other hand, it projects organicism because of the implication of elaborate integrated structures necessary to carry out such a complicated process. This latter judgment is made within the broader context referred to above, in the Overview (p. A78).

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[1] Refer to Appendix V, p. A189 and pp. A198-A200.

42R35-50 ("RIBOSOMES")

Analysis

There are three identifying features of this passage that indicate the projection of mechanism. The first indication is, again, the reduction of phenomena to reactions among particles. Statements, such as "these bodies . . . are the sites of protein synthesis" (42R39-41), are clues to mechanistic reductionism. A second clue is the use of the term "mechanism" in the statement "new protein molecules are constantly being assembled on the surface of the ribosomes by a mechanism involving some of the nucleoprotein material" (42R41-44). The phrase "involving some of the nucleoprotein material" implies that the mechanism itself will be explainable in terms of molecules and, therefore, is reductionist. The third indicator of mechanism is the quantification of the description of ribosomes in 42R46-50.

43R3-29 ("CHLOROPLASTS")

Analysis

There are several statements within this section that project a formist world hypothesis due to the assumption of similarity. The first of these is the statement that "all green plant cells . . . contain bodies called plastids" (43R4-5). A class is named (all green plant cells) according to a collection of particulars that participate in a certain character (contain plastids). A similar analysis is applicable to the statement "chloroplasts are the centers of photosynthesis in the plant cell, practically all forms of life on earth being completely dependent for their existence on these small cell bodies" (43R14-18). Here again, a similarity is observed among "all forms of life." Similarity again projects formism in the statement "nearly all living things use oxygen" (43R28-29).

45L10-29 ("The many chemical. . .")

Analysis

The analysis of this section concentrates on the statement that "genes, molecular units within the chromosomes, determine the entire physical make-up of newly created cells" (45L26-29). This statement projects mechanism because physical structures of a cell are explained in terms of particles (molecules).

48L1-R23 ("AGGREGATION OF CELLS")

Overview

The analysis of this section shows the implication of an organicist world hypothesis and is consistent with the analysis of section 28L16-30L14 (pp. A67-A69). In both sections there is an implicit denial that complex phenomena ("aggregation of small particles into wholes" [28L17], "aggregation of cells" [48L1]) can be explained by a strict mechanistic framework involving attractions and repulsions of particles. This appears, then, to be a possible trend which will be looked for in the remainder of the analysis--namely, as the complexity of the organisms increases, the projected world hypothesis tends toward organicism.

A second noticeable feature of the analysis of this section is that there is an apparent contrast between the assumptions of two projected world hypotheses: mechanism and organicism. This occurs (as explained below) in the two statements in the following sentence: "unlike aggregation in the inorganic universe where gas and particles probably form star and planet embryos chiefly as a result of random collision and retention by gravitational force, cells join other cells in a very specific and controlled manner" (48R6-11).

Analysis

The detailed analysis can begin with the sentence just quoted: "unlike aggregation in the universe. . ." (48R6-11). Here, according to the arguments of the analysis (pp. A69-A72) of a previous section (22L1-R9), the use of "random collison" (signifying chance) is indicative of a mechanistic world hypothesis. The second statement (48R10-11) in the sentence denies that the same explanation is appropriate for the phenomenon of cell aggregation and, consequently, also denies a mechanistic world hypothesis.

It is within the context of the denial of a mechanistic world hypothesis and the analysis of section 28L16-30L14 that this section is judged to project organicism. The last statement in this section (48R18-23) implies some kind of integration and, therefore, can be judged as projecting organicism.

Comment

It should be clear that, as in the case of 35L16-26 (pp. A75-A77), sometimes there is a denial of a world hypothesis (anti-projection) with little implication of another world hypothesis. In this section, then, there is a fairly explicit denial of a strict mechanistic framework to interpret cell aggregation, but a less firm projection of an alternative framework. This is important to notice because conceptually it creates a gap which might be filled by context (as is the claim here) or by a subsequent projection of an alternative world hypothesis.

Chapter Five

"Cell Reproduction"

49L1-31 ("INTRODUCTION")

Analysis

Two statements within this section project formism. The first is "the universal pattern of death following birth includes all animals and plants" (49L2-5). Formism is projected because a similarity is observed which allows classification of entities into the category "living things" (animals and plants).

Formism is also projected in the statement that "frugal nature has decreed that once an organism has carried out its primary function of reproducing other members of its species, its cells must release to the soil or water the substance from which these newer organisms are built" (49L20-26). The metaphor implies that the "decree" is an existent form which nature follows.

Comment

It is worthwhile noting the case where exceptions to a similarity occur, as in the observation that single-celled organisms do not follow the universal pattern of death following birth (49L7-11). While organisms are classified according to their similarity, it is also clear that organisms are distinguished on the basis of their dissimilarity. This is consistent with a formist world hypothesis since the observation of difference depends on the concept of similarity.

51R39-48 ("Anaphase")

Analysis

The analysis of this section is to point out the use of the term "mechanism" which sometimes is indicative of a mechanistic world hypothesis because it implies that the location and action (by contact) of a machine are essential for its description. In the following sentence the term "mechanism" is symptomatic of this: "one newly-formed chromosome of the pair migrates towards the centriole nearest to it, guided apparently by the spindle fibers and motivated by some unknown mechanism or process." (In the discussion of cell division on page 51 it should generally be noted the extent to which mechanism is projected because of an attempt to locate mechanisms which can account for a process of cell division.)

55R1-16 ("CROSSING OVER. . .")

Analysis

There are several reasons why this section projects mechanism. First, there is a mechanistic reduction of an explanation of observable phenomena like "eye color" (55R13) in terms of discrete particles. The particles are "DNA molecules consisting of molecular groups, the arrangement and sequence of which appear to form a 'code' . . . which determines character traits of the organism . . ." (55R7-11). Mechanism is also projected because an explanation of genetic coding is given in terms of an analogy based on a machine: "may be compared with instructions given by punched cards in data machines" (55R14-16).

Chapter Six

"Cell Physiology"

56R13-14 ("All cells. . .")

Analysis

The statement that "all cells exhibit the following life processes" (56R13-14) projects formism because similar characteristics are noticed which allow classification of certain phenomena. (It appears, in the application of the scheme so far, that one may expect throughout to find formism projected in the preliminary statements of a section which discusses structural features and processes of organisms.) The observation of commonality or similarity of things in the world is, of course, the root metaphor of formism, and statements which either assume or imply this intuition of similarity are said to project formism.

58L15-16 ("Cellular control. . .")

Analysis

The statement that "cellular control is essentially molecular control" (58L15-16) projects mechanism because it involves reducing explanations and descriptions of cells to inferred particles.

Comment

It is worthwhile to compare this analysis with the analysis of 48L1-R23 ("AGGREGATION OF CELLS") on pp. A81-A82. In that section there was an implication of an organicist world hypothesis, while this statement (58L15-16) projects a mechanistic treatment of cell processes. It is clear that the two sections deal with different phenomena, though in either case with aspects of cellular biology (aggregation and it is, therefore, not unreasonable to expect a common perspective to be projected from the two sections.

63L6-R25 ("ACTIVE TRANSPORT")

Overview

As in the analysis of section 48L1-R23 ("AGGREGATION OF CELLS", pp. A81-A82), this section implies that a strict mechanistic world hypothesis is not adequate for interpreting certain biological phenomena.

This is again a case where the inadequacy of one perspective is more clearly projected than the adequacy of another perspective. The claim that organicism is projected in this section is not a strong one and depends on the context of sections previously analyzed (e.g., 43L1-R23).

Analysis

Several statements in this section indicate that the mechanistic perspective projected in the discussion of diffusion, dialysis and osmosis (pp. 59-61) is not adequate to account for active transport. Those processes (63L7-18) are considered to "not explain how food substances in fairly dilute solutions in the intestines pass into the blood, which has already become concentrated with these food materials" (63L18-22). This statement projects the inadequacy of a mechanistic world hypothesis for explaining some phenomena.

It is a more tenuous claim to say that organicism is projected. A clue to its projection, however, occurs with the statement that "the membrane must be able to select certain substances and reject others, irrespective of the concentrations on either side of it" (63R6-9). This projects organicism to the extent to which it implies an integrated system capable of performing such a process.

Comments

Several general comments are in order. First of all, some of the analysis is clearly a problem of detecting shifts in focus. For example, this section on active transport continues to project mechanism in the sense that movement of materials across membranes is discussed in terms of the interactions among discrete particles. But a shift in focus occurs when the explanation moves from a total reliance on differences in concentration to active transport. This shift in focus has been noticed in several other areas (e.g., cell aggregation, 48L1-R23, pp. A81-A82; Second Law of Thermodynamics, 11L1-12L36, pp. A61-A64; coordination, 32R6-29), p. A75. In each case it is important to note that the student is not provided with concepts by which to be aware of the implications of those shifts.

Chapter Seven

"Cell Chemistry"

64R5-66L18 ("In spite of. . .")

Overview

Generally, a mechanistic world hypothesis is projected in this chapter because there is an effort to provide descriptions and explanations of the cell in terms of discrete particles (molecules and atoms and their complexes). The analysis of this section shows the projection of mechanism because of reductionism, location, and quantification.

Analysis

In mechanism things are real by virtue of a location in time and space. Thus, in the statement that Dr. Sanger "announced the precise order and arrangement of the 777 atoms in the molecule" (64R13-66L1), mechanism is judged to be projected because "order and arrangement" are aspects of location. The fact that the discovery was considered significant (66L5) seems to emphasize the projection of a mechanistic world hypothesis. (This is an instance of emphasis discussed above, pp. A57-A59.)

Mechanism is also projected because of quantification. In discrete mechanism, primary qualities refer to quantifiable operational aspects of a machine (size, shape, motion, solidity, mass, and number). It is in this sense that mechanism is projected in the phrases "of the 777 atoms in the molecule" (64R14-66L1), "molecular weight of 5733" (66L2), "one containing 1876 atoms and the other with over 2000 atoms" (66L10-11), and the statement "polypeptides consist of 100 to 10,000 amino acid units, and proteins are composed of over 10,000 amino acid units" (66L15-18).

66R1-43 ("ENERGY WITHIN THE CELL")

Analysis

Formism and organicism are projected in the same sense that they have been judged to be projected in the analysis of 11L1-12L36 (pp. A61-A64). That is, formism is projected because of the way in which the thermodynamic laws are talked about, and organicism is projected because of an apparent contradiction in nature.

68L10-12 ("a maintained temperature. . .")

Analysis

This analysis is to point out the way in which death in human beings is discussed. The statement "a maintained temperature of 106°F in man will cause cell reactions to run out of control, and the individual dies" (68L10-12) projects mechanism because an observable phenomenon (death) is explained in terms of interactions among discrete particles.

"UNIT THREE: ORGANIZATION OF HIGHER ANIMALS"

Overview

The selected analysis of Unit Three shows the projection of formism, primarily because descriptions of structure and function are in terms of similarity observed among higher animals. In most cases the substantive explanation for continuity lies in genetic and evolutionary theories. Aspects of both of these theories project mechanism as is evident from the analyses of 55R1-16 (p. A84) and 22L9-R9 (pp. A69-A72).

Chapter Eight

"Reproduction and Development"

79L1-29 ("INTRODUCTION")

Analysis

Formism, mechanism, and organicism are projected in this section. The projection of formism is seen in the generalization that "most animals . . . start life as a speck of matter . . ." (79L2-4). A similarity among animals is observed, and in formist terms this similarity is a character in which a collection of particulars (animals) participate.

Mechanism is projected because observable structural features of organisms are discussed in terms of discrete particles. This is particularly clear in the statement that "the arrangement of atoms within the complex molecules of DNA constitutes a 'code' by means of which the structural features of the animal are determined" (79L9-13).

Organicism is projected because of what is implied by specialization (79L23, 79L27-28) and system (79L27). The implication is that a degree of integration is necessary among the parts of an organism if it is to operate as a whole.

Chapter Nine

"The Skeleton"

93L3-7 ("Bones similar. . .")

107L6-15 ("In spite of. . .")

Analysis

The statements in these two sections are judged to project formism because of the assumption of similarity. The terms "similar" and "form" are strong clues in 93L3-7. The observation of similarity is obvious in the section 107L6-15, where the basis for classification is asserted to be similar structures.

Chapter Ten

"The Muscular System"

114L15-R30 ("THE MOVEMENT OF MUSCLES")

Overview

The analysis of this section shows the projection of mechanism because of the location of parts, quantification, and action-by-contact. Pepper states that "the lever or the push-and-pull machine. . .stresses action by contact. . . ."[1] The description of a lever, of course, uses quantification and location and assumes the action-by-contact paradigm. A number of the statements in this section project these features of mechanism. One will be analyzed in detail.

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[1] Pepper, World Hypotheses, p. 187.

Analysis

The claim that "skeletal muscles operate by causing the bones to act as levers" (114L16-17) puts the rest of the discussion in the context of a mechanistic framework. Quantification and location are shown in the phrase "if a weight is attached to the phalanges of one hand and a spring balance is secured to one of the bones of the forearm about 1.5 inches from the elbow" (114L22-26). Here phalanges, bones of the forearm, and elbow are in the description for purposes of locating the parts so that it can be shown how the machine (lever) works. Quantification of the distance from the elbow (1.5 inches) helps to locate the position of one of the parts. This description assumes an action-by-contact paradigm and consequently projects mechanism.

114R31-117R14 ("THE PHYSIOLOGY OF. . .")

Analysis

This section is judged to project mechanism because the observable phenomenon of muscle contraction is explained in terms of chemical reactions among discrete particles (molecules). Mechanism is also projected because of quantification of aspects of the chemistry of muscular contraction. The reduction of observable phenomena to reactions among discrete particles is evident in the statement that "contraction of muscle fibers is triggered by the stimulus of a nerve impulse and the release of acetylcholine, a chemical substance that functions widely as a key agent in the transmission of nerve impulses" (114R36-40). Acetylcholine is the particle that aids the operation of a mechanism that results in observable muscle contractions. Energy is released in the change of ATP to ADP (moleculas) and "produces a contraction of the myofibrils in the muscle fibers" (117L3-5). Ultimately this produces an observable muscle contraction--an explanation which projects mechanism because of the reductionist paradigm assumed in the explanation.

Mechanistic reductionism is also assumed when shivering ("large skeletal muscles will contract involuntarily" 117L17-18) is explained by reactions of discrete particles ("breakdown of glucose by the process of aerobic respiration" 117L23-24). Finally, mechanism is projected because of quantification in the description of muscle relaxation ("38 molecules of ATP furnishing 340,000 calories of energy" 117R2-3).

115 FIG. 10:5 ("THE PHYSIOLOGY OF MUSCLE FIBERS")

Analysis

Figure 10:5 shows that diagrams can also project world hypotheses. The diagram is judged to project mechanism because it pictorially shows the reduction of an observable muscle block to small units, culminating in a diagram which pictures ATP molecules.

117R15-118R11 ("MUSCULAR CONTRACTION")

Overview

This section projects mechanism for the same reasons as the preceding two sections. The analysis of this section, however, will concentrate on the reasons for judging organicism to be projected.

It is projected because of the way in which the inquiry into problems concerning muscle contraction is reported.

Analysis

The first suggestion of the projection of organicism is in the following two statements: "the reason for muscle fatigue is not quite as simple as this;" "experiments with muscle have shown that contraction can occur even when there is no oxygen available" (117R34-118L4). Prior to these two statements it has been suggested that muscle fatigue (implying inefficient muscle operation) results from a lack of oxygen. Experiments and data about sprinters, however, seem to contradict much of what is known about muscle contraction (what is known, that is, from the preceding material on the chemistry of muscle contraction 117L9-R33). In organicist terms, existing knowledge of muscle contraction, data about sprinters, and the relevant experiments are all fragments whose nexuses lead to contradiction which implies a higher level of integration. This higher level of integration is found when "the discovery was made that a substance called phosphocreatine played an important part in sustained muscle contraction" (118L29-32). The discovery of this chemical (and its associated mechanism) provides a larger organic whole from which one can see that the original contradictions are not really contradictions.

Comment

The projection of organicism is based on phrases like "experiments . . . have shown" (118L1-2), "the answer seemed to be" (118L21), and "at this point in the research" (118L28). Such phrases reflect the history of the investigations into muscle contraction. Such a history was the vehicle for Pepper's explication of organicism. Neither this comment nor Pepper's explication is meant to imply that historical reconstruction is the only instance by which one intuits an organicist framework. It does seem to be the case in this section, nevertheless.

Chapter Eleven

"The Respiratory System"

119L1-121L54 ("THE DEVELOPMENT OF RESPIRATORY SYSTEMS")

Overview

As in the analyses of sections 48L1-R23 (pp. A81-A82) and 63L6-R25 (pp. A85-A87), this section implies that strict mechanistic categories are not sufficient to account for some phenomena in more complex organisms. Thus, even though mechanism is still projected in this section, there is evidence for a shift in emphasis which possibly implies an organicist perspective. Again, the claim for a shift toward organicism is not a strong one. The shift could, for example, be interpreted as a more complex mechanism. However, if one reflects on the sequence of the entire text (culminating with the unit "Interdependence of Organisms"), there is, generally speaking, a development from simple to complex or from molecule to ecosystem which implies a shift from mechanism to organicism. Such a shift appears to be mirrored in this section (119L1-121L54).

Analysis

Mechanism is projected in the first paragraph (119L3-22) because gas exchange is accounted for by a diffusion model that assumes a mechanistic perspective. Mechanism is also projected because the entire discussion assumes reductive explanation in terms of discrete particles. In two places the term mechanism (119L7, 18) provides a clue to the projection of mechanism as a world hypothesis.

A slight shift in emphasis is seen in the statement that "as multicellular animals are larger and more complex, it is no longer possible for the animal to obtain sufficient oxygen through its body surface" (119L23-26). The next statement (119L26-30) contains an implicit reference to a circulatory system which, as has been argued, assumes some form of integration. Later, the reference to systems is repeated: "insects evolved a tracheal system" (119R26); "transportation system" (121R40); "the lungs and the circulatory system" (122L13-14). (It is also significant, of course, that the title of the chapter is "The Respiratory System.")

121R1-122L45 ("INTERNAL AND EXTERNAL RESPIRATION")

Analysis

The implication that organs and systems are integrated to allow the organism to live occurs in at least two statements: "the involvement of lungs, blood, and lymph in getting the oxygen to the cells is called external respiration" (121R10-12); "the absorption of oxygen into the body for the purpose of internal respiration within the cells is achieved by two respiratory mechanisms, the lungs and the circulatory system" (122L10-14). Again, the strength of the claim for projection of organicism rests on the degree to which the concept system implies organicist categories.

Within this same section, mechanism is projected because of the reduction of aspects of the explanation to discrete particles. This occurs, for instance, with the statement that "in the chordates, the combination of oxygen with the blood pigments results in the formation of oxyhemoglobin" (121R50-122L2). Mechanism is projected because quantification is an obvious factor in the description of external respiration which is seen in this statement: "fish and other aquatic animals have available only three to five volumes of oxygen in 100 volumes of water, whereas oxygen amounts to one-fifth of the total volume of air" (121R20-24).

Comment

This section illustrates well the complexity of trying to judge which world hypothesis is projected. The judgment is complex and difficult because projection occurs at different levels of analysis. The detailed description of external respiration, for example, tends to be mechanistic, whereas the context of the discussion (remarks in the previous section, title of the chapter, introductory statement 121R10-12) indicates a probable shift in emphasis toward organicism. And, of course, a phrase like "is achieved by two respiratory mechanisms, the lungs and the circulatory system" (122L12-14) can be considered to project both mechanism and organicism--mechanism because of the explicit reference to "mechanisms," organicism because of the implication of integration of the two mechanisms and because of the implications of the term "system." The question of which world hypothesis is projected in this section is not an important one. What is important is that mechanism and organicism seem to be projected to a larger extent than are the other world hypotheses.

122L15-45 ("INTERNAL RESPIRATION")

Analysis

This section projects mechanism because of the reduction of explanations of life processes to reactions among discrete particles as in the statement that the process of internal respiration "consists of the oxidation of food by the removal of hydrogen ions . . . and the consequent release of energy in a series of bursts which change ADP molecules to ATP" (122L18-23).

124L8-R14 ("Behind the tongue. . .")

Analysis

This section projects mechanism because an action-by-contact paradigm is assumed and because the location of parts is an important aspect of the description. The assumption of an action-by-contact paradigm is clear in this statement: "in order to ensure that no food passes into this opening, the action of swallowing involves an upward movement of the entire larynx, or voice box, so that the upper part makes contact with the epiglottis" (124L12-17). Something physically has to be done to prevent food from passing into the glottis and the physical action involves the movement and contact of discrete locatable parts of the throat. The action-by-contact paradigm is again assumed in the statement "In speech, the alternate stretching and relaxation of the vocal cords and consequent narrowing of the glottal opening produces low- and high-pitched sounds which, modified by the lips, teeth, and the resonating cavities of the mouth, nose, and chest, become articulated speech" (124L46-52).

In a mechanistic world hypothesis the exact description of a machine requires the specification of the location of the parts. Throughout this section (124L8-R14) there is an effort to locate parts of the throat in relation to each other. Location is an important issue, for example, in the following statement: "behind the tongue and projecting into the throat is the epiglottis, a flap of tissue sealing the glottis, or opening into the larynx" (124L8-11).

Comment

Again, different world hypotheses stress different issues even though they attempt to account for all phenomena in the universe. So, for example, in the case of action-by-contact, mechanism is the one world hypothesis that stresses this paradigm. Contextualism, organicism, and formism do not deny action-by-contact; instead, they focus on different issues. It is probable that mysticism and animism do deny action-by-contact as a necessary requirement for causal events. The claim that mechanism is projected when action-by-contact is assumed is to say that it is projected because it is the world hypothesis for which action-by-contact is an issue.

124R24-38 ("A little below. . .")

Analysis

Mechanism is judged to be projected in this section because quantification plays an important role in the description as is evident from the statement that "six hundred million of these alveoli in both lungs provide a surface area of about 800 square feet, the area of a tennis court" (124R31-34).

Chapter Twelve

"The Circulatory System"

129L1-29 ("THE NEED FOR BLOOD")

Overview

The analysis of this section shows a shift from mechanism to organicism which is reflected in the entire chapter. The analysis of this section, therefore, serves as a background from which one can examine the rest of the chapter.

In this section a familiar theme is repeated, the explication of a system in terms of a hierarchy of organisms (simple to complex). The projection of world hypotheses alternates between mechanism and organicism. Some statements project mechanism while others project organicism.

Analysis

The statements in 129L1-9 project mechanism because a simple diffusion mechanism can account for how the organism acquires oxygen. Diffusion alone, however, is not regarded as adequate in more complex organisms (129L16-19) and consequently a mechanistic world hypothesis is projected as not totally adequate. Organicism is projected as the alternative to this situation in the statement that "since the triploblasts include all animals from worms to man, the majority of these animals possess a circulatory system, whose function it is to carry materials to and from all cells of the body" (129L24-28). The clue is the term "system." The claim that organicism is projected is strengthened by context provided by prior statements which imply that a mechanistic framework is not adequate to account for some phenomena in complex organisms.

Comment

Further indications of the projection of mechanism and organicism can be found throughout the chapter. For example, organicism is sometimes projected because of the implication of a complex "feedback" mechanism which allows the organism to survive. In section 133R45-134L10, for example, "feedback" mechanism (implying integration) is necessary to control leucocyte production when the infection is gone, or to increase leucocyte production when the infection worsens. It is in this sense that organicism is judged to be projected. Organicism is projected in a similar sense with the statement that "in order to adjust to the drop in volume of blood in the surface tissues, the vessels in the muscles and skin constrict so that . . . the pressure remains the same" (136L15-19).

Mechanism is projected in the following statement because of quantification: "red bone marrow must manufacture 2,500,000 to 3,000,000 red corpuscles every second" (133R18-20). Quantification also operates to project mechanism in the description of blood pressure (e.g., 144R3-21). Mechanism is projected in the following statement because of the emphasis on locating a manifestation (sound) of heart operation: "recent work . . . has revealed that the sounds originate in the vibrating walls of the atria and ventricles" (143L12-15).

It is helpful to comment with regard to the "picture" presented in this chapter. There is some evidence to indicate that organicism tends to be projected as the complexity of organisms increases. So, for example, in the sections that follow this one, the circulatory systems of increasingly complex organisms are discussed. It seems fair to say that a discussion in terms of system is a potential indicator of a shift toward an organicist framework.

However, to continue this example, the complexity of what is potentially projected to a student is highlighted if we ask the question "Why did the circulatory system develop?" A teleological answer to this is that circulatory systems developed to get blood to parts (tissues and cells) of the organism so that certain kinds of action (respiration) necessary for life can take place (e.g., 129L16-29). However, a concept of getting a fluid from one place to another so that something can happen assumes an action-by-contact paradigm and consequently projects mechanism, provided that this aspect of the explanation is the focus for the reader.

137R6-138R18 ("THE DEVELOPMENT OF THE HEART")

Overview

This section is judged to project organicism for two reasons. On the one hand, there are, in the history of heart study, fragments or pieces of data that cannot be accounted for and therefore exist as contradictions in nature. Organicism is projected because organicist categories account well for aspects of the history of heart research. Similarly, organicism is projected because there is an implication that mechanistic perspectives are not adequate to account for some phenomena in heart development. This second claim is supported mainly from context.

Analysis

The claim that organicism is projected in this section concerns statements dealing with the history of heart research. The history is described in a limited way as indicated by such strings as "one theory is" (138L5), "modern research" (138L13), "the work on embryonic tissue" (138L20), "in research into mammalian cardiac tissue" (138L54-55), and "further work indicated" (138R8). In this research there are phenomena (fragments) that do not yet fit into a coherent picture. One of the fragments is "how individual cells in a growing embryo organize themselves into specific organs" (138L2-4). Research provides a higher level of integration that helps to put the original fragment into a more integrated whole. For example, there is the theory that "the influence of neighboring cells and certain enzymes enables particular genes to operate" (138L7-9). This theory, however, meets contradictory fragments, e.g., "heart tissue is developed from cardiac muscle myosin which is widely distributed in early embryonic mesoderm" (138L15-18), and "further development of cardiac tissue took place a little later in specific embryo regions" (138L18-20). More integration, more coherence, and more truth is reached with the discovery of the migration of heart cells along the primitive streak (138L38-46). These statements show that the categories of an organicist world hypothesis can account for the history of heart development research as it is presented in this section.

Sometimes organicism is projected weakly because it is implied that mechanist categories are not adequate to account for some phenomena. This seems to be the case in this section, and support for the claim comes from context.

The first hint that a mechanistic world hypothesis is limited comes with the statement that "there are many occurrences within living organisms about which biologists know little or nothing" (137L12-138L1). The reason that this is judged as *not* projecting mechanism is that prior context shows the vast amount that *is known* from a mechanistic perspective (cell chemistry, physics, chemistry, etc.). (The claim here is not strong, and clearly the context moves outside the textbook.)

Following this is the problem of "how individual cells . . . organize themselves" (138L2-3), which implies something more complicated than random molecular motion discussed earlier in the text. "Organize themselves" implies some high degree of structural integration, and consequently projects organicism.

142L28-R18 ("PHYSICAL CONTROL OF THE HEART")

Analysis

An organicist world hypothesis is projected in this section because of the assumption of a high degree of integration among tissues and organs in heart control. Such integration is implied when it is stated that impulses from the distended *vena cava* nerves "cause the medullary nerves to accelerate the heartbeat to deal with the larger volume of blood entering the heart" (142L50-52). The antagonistic action of the aorta (142R4-11) indicates a "feedback mechanism" which implies integration.

148R20-35 ("The way in which . . .")

Analysis

Both organicism and mechanism are projected in this section. Organicism is projected because the history of research shows fragments which lead to contradictions (competing theories in this case). Mechanism is projected in that the phenomenon of immunity and resistance is explained in terms of discrete particles, as in 148R27-30 ("certain atoms in the molecules of antibodies possess free electrons that enable bonds to become established with atoms within the antigen molecules").

Chapter Thirteen

"Nutrition"

149L1-14 ("THE DEVELOPMENT . . .")

Analysis

Statement 149L10-14 projects formism because a *similarity* is noticed among all organisms. This similarity can be interpreted according to both immanent and transcendent formism. Immanent formism is projected because the statement implies the *observation* of similarity. Transcendent formism is projected because of the implication that organisms *grow* or *develop* according to a similar plan--one aspect of that plan being the process of assimilation. (The transcendent formist notion of natural objects growing according to the same plan is also seen in the following statement: "the basic plan of a body surrounding a space through which food passes is found in all animals from annelids to man," [150L21-23].)

Comment

In most discussions of organisms there is an assumption of the similar/dissimilar distinction. For example, in the discussion of cell physiology (Chapter 6) it is assumed that a generalization based on similarity is made about the cell physiology of organisms. Generally, the descriptive comparison of organisms assumes a formist root metaphor. In this sense this entire text projects formism. Moreover, the analysis focuses on statements that present a strong clue to the formist metaphor, particularly when specific terms are present that have a unique meaning within that hypothesis (e.g., same and plan in the above two statements).

154R27-155R38 ("NUTRIENT MATERIALS")

Analysis

The discussion of nutrient materials covers carbohydrates, lipids, proteins, water, and mineral salts. Only the discussion of carbohydrates and part of the discussion of lipids is included in this analysis to show the projection of mechanism. Mechanism is projected because aspects of the explanation of nutrition are reduced to discrete particles. Typical statements reflect this reduction: "like all food substances, they will release energy when the chemical bonds which hold their atoms together are broken" (154L35-37), and "lipid molecules contain carbon, hydrogen, and oxygen in the approximate ratio of 1:2:1/8 . . ." (155R4-6).

164R5-23 ("At the base of man's . . .")

Analysis

This section is judged to project organicism because a contradiction in nature is observed: "the appendix has no function in man and is a frequent site of inflammation" (164R9-11). The contradiction arises from the observation that, on the one hand, in man the appendix has no function and from the assumption that, on the other hand, structures exist in organisms for a function. In this section organicism is projected through the category of contradiction. Later in the text a higher level of integration incorporates these fragments in a more coherent whole and the contradiction dissolves. A sense of higher integration lies in the theory of evolution and comparative morphology and is encapsulated in these later statements (374L2-14): "serial homology thus affords more evidence of gradual evolutionary development either forward or backward;" "when viewed in this light, certain rudimentary and very often useless structures take on a new meaning;" "the coccyx of man consists of four tiny bones that constitute a vestigial (functionless) tail;" "man also possesses a wormlike protrusion of the intestine known as the vermiform appendix, which has no function in man but assists in the digestion of cellulose in herbivorous animals."

Chapter Fifteen

"Excretory System"

167R1-169L26 ("The organs that . . .")

Overview

It is helpful to have an overview of this entire chapter since some of the issues, in respect to world hypotheses, are similar to the issues discussed in the previous chapter. Basically, the discussion in this chapter involves showing the development of complex excretory systems in lower animals. Simple systems are interpreted as operating according to a diffusion gradient, while more complex systems are interpreted as operating in a way which involves the notion of active transport. Therefore, some phenomena, like simple excretion, can be accounted for by a mechanistic world hypothesis while other phenomena (e.g., mammalian kidney function) are not easily accounted for according to the categories of that world hypothesis. Organicism would be more appropriate.

As was the case with Chapter 12, sometimes a world hypothesis is projected as being inadequate, but no clear alternative is projected. For example, it is difficult to judge whether active transport implies an organicist world hypothesis or a highly sophisticated mechanistic view. The judgment of this investigator tends toward the interpretation that organicism is projected because a mechanistic world hypothesis (at least in its discrete form) is considered inadequate for the phenomena at hand, and because the context (discussions of "feedback" mechanisms, homeostasis) implies a high degree of organic integration.

Analysis

Several statements in this section project a discrete mechanistic world hypothesis, because excretion is accounted for by a simple diffusion gradient, as in the following statements: "the coelenterates . . . require no osmo-regulatory device since the inside and outside cells of the body are everywhere in contact with water;" "in addition, oxygen and carbon dioxide can easily diffuse from cell to cell throughout the body" (167R32-168L2).

Several statements imply an organicist world hypothesis because of the implication of integration. For example, organic integration is implied in "osmo-regulatory device" (167R19) because of "feedback" mechanisms operating in regulatory control. And, in the discussion of waste removal in triploblastic organisms, the statement is made that "waste passes by active transport through the lining of the tubule walls and passes out through the nephridiapores" (168R1-4). The process of active transport suggests an organicist world hypothesis because the process is for regulation, which implies the integration of organs, systems, and processes. For similar reasons, the implication of integration is seen in "high-pressure blood filters" (169L5) and "selective filtration apparatus" (169L22-23).

Comment

It is worthwhile to reflect on another possible way that organicism is projected--the integrating qualities of the theory of evolution. An organicist world hypothesis sees all experience integrated into larger more coherent wholes. The theory of evolution constitutes an integrated whole from which the contradictions of fragments are resolved. The contradictions which evolution resolves come from comparative morphology and anatomy, geology, embryology, etc. Data or fragments of experience in these fields are successfully and coherently integrated with the theory of evolution and, from the perspective of evolution, are not seen to be contradictory.

An organicist interpretation of evolution serves as a perspective from which to examine the statement that "the basic plan of the chordate kidney tubule common to most vertebrate animals appears in the developing mammalian embryo and offers an example of recapitulation whereby the embryo passes through structural stages similar to the embryonic stages of more primitive animals" (169L6-12). However, the reason for seeing recapitulation as an issue reasonably lies in an organicist interpretation of the theory of evolution. Recapitulation is an observed fragment of experience which is integrated into evolution as a coherent theory. In a sense, then, this statement "prepares the student" for an organicist interpretation of evolution later in the textbook.

It is also important to mention the implication of formism that runs through this passage. This world hypothesis is projected by such terms as "basic plan," "common," and "similar" (169L6-12). Whereas to this point in the analysis there has clearly been an organicist/mechanist projection in the discussion of the development of complex systems, it is interesting to speculate that discussions of "evidence for evolution" might project an organicist/formist framework. This will be discussed later in the analysis.

171R12-173R8 ("KIDNEY FUNCTIONING")

Analysis

Both mechanism and organicism are projected in this section. Mechanism is projected because aspects of kidney function are described by simple diffusion gradients, e.g.: "At the glomerulus, diffusion takes place through the membranes of the cells making up the capsule" (171R20-22). Mechanism is also projected because the reductionist description of kidney function is in terms of discrete particles: "retained by the blood are the large protein molecules of albumin, and globulins, and erythrocytes" (171R26-28), "this energy is released at the lining of the tubule by ATP molecules . . ." (172R28-32). This last statement points to another aspect of a mechanistic world hypothesis--the location of the functioning parts of a machine. In this statement (172R28-32) it is clear that where the energy is released is an issue. The location of various parts of the kidney runs through this entire section.

The projection of organicism has been dealt with in some detail in the previous section and the problems encountered with the claim that organicism is projected hold for this section also. This analysis focuses on "active transport" (172R21) and "homeostasis" (173R5) as concepts which project organicism because of the implication of some kind of integrated process for the purpose of maintaining the organism.

Comment

It is clear that it is difficult to judge whether organicism is projected or whether a more sophisticated mechanism is projected. In most cases, this investigator opts for organicism on the basis of an implied integration. But the argument for organicism only on the basis of its ambiguous root metaphor is a tenuous one. On the other hand, there is an intuitive reluctance on the part of this investigator to consider explanations involving homeostasis as projecting mechanism.

The scheme appears to be weak on this issue and, therefore, distinctions between the projection of mechanism and organicism are difficult to make. Perhaps a useful distinction between mechanism and organicism lies in a concept of structure-function or some form of teleology, but Pepper's treatment of mechanistic and organicistic categories does not deal with this.

An inadequacy of the scheme appears to be unfolding. It might be compensated for by yet another world hypothesis. It was developed later by Pepper in Concept and Quality, and was discussed more recently by Laszlo in The Systems View of the World. While this world hypothesis, selectivism (Pepper) or systems view (Laszlo), is not incorporated into this study, it is important to recognize that it deals specifically with aspects of purposive behavior and, therefore, might fill the schematic gap that appears to be developing.

Chapter Sixteen

"Coordination and Chemical Control"

174R3-34 ("The delicate chemical control . . .")

Overview

Several statements in this chapter project organicism because of implication of integration in a concept of homeostasis. Support for claiming the projection of organicism comes from implicit references to the whole organism. The emphasis on the whole organism, combined with assumed integration, makes a stronger case for the projection of organicism.

As with several previous analyses the first hint of the projection of an organicist position comes with an indication that a strict discrete mechanistic framework does not account for the phenomena observed. Again, it is difficult to say whether such an indication consequently implies an organicist framework or a more complex mechanist one. Because of the implication of integration and wholes, this investigator generally judges such statements as projecting organicism.

Analysis

In this section (174R3-34), both mechanism and organicism are projected. A statement such as "one of the mechanisms of steady state control is 'feedback,' which may be compared with thermostatic control of house heating . . ." (174R6-9) projects mechanism because of the comparison of feedback to an actual mechanism. For the same reasons the following statement also projects mechanism: "the living organism is a highly tuned and sensitive machine . . ." (174R26-28). However, that statement (and the entire section) must be read in the context of the subsequent statement that "unlike a mechanical machine, it can make readjustments which enable it to go on living" (174R28-30). This statement is crucial because it suggests that a strict, discrete mechanistic view does not account for homeostatic control.

This section projects organicism because of an implicit emphasis on the whole organism. This can be seen in the following two statements: "without this control an organism cannot exist" (174R28-29); "the living organism . . . can make readjustments which enable it to go on living" (174R26-30). The complexities of "homeostatic control (implying integration of systems, organs, and tissues) are seen as serving the purpose of keeping the whole organism alive.

176L11-30 ("The fundamental effect . . .")

Analysis

This section is analyzed as an example of the projection of mechanism due to reduction. Observable qualities like "lean" appearance (176L25) or "energetic" behavior (176L25) are reduced to or explained by reactions among discrete particles. For example, increased oxidation of food (ultimately resulting in the observation of "lean" and "energetic") is "accomplished by uncoupling the phosphorylation process from oxidation . . . so that energy, instead of passing to ADP molecules, is released directly as heat" (176L13-17).

176L47-R34 ("SIMPLE GOITER")

Analysis

The analysis of this section shows the projection of both mechanism and organicism. Mechanism is projected because of reduction of an observable condition (hypothyroidism) to an explanation in terms of discrete particles (lack of the element iodine, 176L48-R3). Organicism is projected because of the reference to homeostatic control (176R10-16).

180R3-43 ("THE PITUITARY HORMONES")

Analysis

This section projects both mechanism and organicism. Organicism is projected by at least two statements because of the reference to homeostatic control: "its hormones regulate the secretion of hormones from all the other endocrine glands" (180R5-7); "just as the output of hormones from the pituitary regulates the secretions from the other endocrine glands, so in turn the regulatory hormones from the pituitary are modified by the activity of the other glands of the body" (180R24-29).

Mechanism is projected because of the effort to locate effective parts. For example, the location of the various parts of the pituitary gland is clearly an important issue in the following statement: "this gland, which lies like a small pea in a small depression on the floor of the skull, consists of an anterior, an intermediate, and a posterior lobe" (180R8-11). In a similar manner, where various hormones come from is another manifestation of the effort to locate effective parts: "a thyroid-stimulating hormone from the anterior lobe controls the amount of thyroxin produced by the thyroid gland" (180R29-32).

Chapter Seventeen

"Coordination and Nervous Control"

185L1-R(FIG. 17:1) ("IRRITABILITY")

Analysis

The analysis of this section will focus on one statement (185L19-21) and the diagram (FIG. 17:1) to show the projection of mechanism and organicism. Mechanism is projected because an action-by-contact paradigm is assumed in the statement that "for an organism to respond to stimulus, an effector mechanism associated with an affector is necessary" (185L19-21). This is further elaborated in subsequent statements. For example, "affector sensory nerves in the finger of man transmit impulses to the central nervous system which will be routed to effector nerves controlling the operation of certain muscles" (185L31-35). The assumption (embodied in the term "necessary," 185L21) is that for an action to occur something has to travel (impulses) through something (nerves) which goes to and from in order for the action to occur. The to-and-from quality of something (the pathway) is important only if causality is conceptualized in terms of action-by-contact.

This section also projects organicism, as is seen by examining FIG. 17:1. Organicism is projected because in this model some kind of feedback mechanism is a part of the affector-effector control pattern. The concept of feedback implies some form of integration among organs, systems, and tissues.

187L1-17 ("The instinct. . .")

198R10-27 ("Research into . . .")

Overview

These two sections are analyzed together because "willfullness" is a common feature. The issue concerns the fact that both mechanism and organicism are deterministic world hypotheses and, consequently, are not consistent with a concept of free will. (The idea of randomness and chance in mechanism as precluding the possibility of will has been discussed in 22L9-R9, pp. A69-A72). The concept of "will" is assumed in these sections and therefore they are judged possibly to project aspects of contextualism.

Analysis

In section 187L1-17 the analysis concentrates on the following two statements: "this and other instincts are usually modified by will-power, prompted by social conditioning" (187L7-10); and "the sex urge is another instinct which man alone modifies by means of will-power" (187L15-17). In section 198R10-27 the analysis concentrates on: "this appestat is influenced or preset by the influence of the will or conscious desires" (198R15-17). These statements do not project mechanism or organicism because a concept of "will" is not consistent with the determinist doctrine in those two world hypotheses. It is more difficult to judge what world hypothesis is projected, although the emphasis on the immediately apprehended quality of "will" and "conscious desire" suggests contextualism.

One additional note concerns the phrase "modified by will-power, prompted by social conditioning" (187L8-10). "Modified by will-power" does not project a deterministic world hypothesis. "Conditioning" does.

Comment

The analysis of these two sections is vulnerable to problems about the meaning of key terms in the statements: for example, will-power, conditioning, conscious desire. Their meaning in these sections is not sufficiently clear to suggest a strong claim for the projection of any particular world hypothesis dealt with in this study.

190L1-26 ("CHORDATE ANIMALS")

Analysis

The statements in this section project mechanism because of location and quantification. The emphasis on locating parts is clear in statements concerning the position of the brain (190L2-5). Quantification is an aspect of the description of the nervous system as is seen in "the maze of nerve fibers carrying these signals are thought to have a combined length of over 100,000 miles" (190L19-22). Mechanism is also projected because of the comparison of the nervous system with a computer or telephone exchange.

193L1-R24 ("CONDUCTION OF NERVE IMPULSES")

Analysis

Mechanism is projected in this section because of reduction, while organicism is projected because of the implications of the process of active transport. Nerve impulses are a phase in the reduction of observable qualities (e.g., movement) to discrete, inferred particles (atoms and molecules). Such reductionism is clear in this statement: "the charge itself is the result of the movement of potassium and sodium ions (charged atoms) across the differentially permeable membrane of the fiber cells" (193L16-19). The reference to active transport and consequent projection of organicism is evident in the statement that "the energy for this active transport comes from the process of respiration" (193R9-10).

196L14-R42 ("THE HUMAN BRAIN")

Overview

In mechanism primary qualities refer to the quantifiable operational aspects of a machine (described by size, shape, motion, solidity, mass, and number) which have a specifiable location. The analysis in this section concentrates on showing the extent to which descriptions of the brain involve size, shape, location and quantification.

Analysis

Quantification is evident in "the brain is composed of approximately 7 billion neurons . . ." (196L17-20). Location is an issue in the description of nerve distribution in the brain ("on the surface of the brain" [196L21-23]). Relational location is an issue in the description of the meninges (196L28-35). The statement that "the remaining and most posterior portion of the brain . . . lies behind and below the cerebellum and . . . constitutes the enlarged, anterior part of the spinal cord" (196R27-31) refers to location and size. Shape and location are issues in the description of the hypothalamus: "the term 'hypo' means below, and the hypothalamus is a wedge-shaped part of the primitive brain situated just below the thalamus" (198L51-R2).

Chapter Eighteen

"Coordination and Sensory Perception"

204L1-27 ("INTRODUCTION")

Analysis

This section projects a mechanistic world hypothesis because of the reduction of observable phenomena to inferred entities. The observable phenomena (or secondary qualities) in this discussion consist of certain observations about human senses. And these senses, vehicles by which secondary qualities are observed, are reduced to or explained by inferred entities (impulses). The reduction is encapsulated in the following statement: "without this flood of information to the brain and nervous system a man would be totally unaware of his environment . . ." (204L15-21).

Reductionism also operates to project mechanism in a description of the senses of smell and taste in a subsequent section: "for these receptors to work, small particles or molecules must first dissolve either in the mucus inside the nose or in the saliva on the tongue" (205R23-27). In that same section, the following two statements also project mechanism because of reduction: "the precise mechanism of smell is not known;" and "one theory recently advanced suggests that there are tiny olfactory pits whose shapes enable molecules of different configurations to fit into them" (206R7-11).

209L13-34 ("THE MIDDLE EAR")

Analysis

The analysis of this section (including FIG. 18:4) focuses on the projection of mechanism because of the assumption of action-by-contact. FIG. 18:4 indicates quite clearly that the parts of the middle ear are in contact with each other. This diagram serves as context for the statement that "a relatively large movement of the tympanic membrane results in a movement of smaller amplitude at the oval window . . ." (209L22-25).

212R1-6 ("THE DEVELOPMENT OF SIGHT ORGANS")

Analysis

This short analysis is merely to show that formism is projected in "light-receptive organs or organelles exist in all forms of animal life . . ." (212R4-5) because of the observation of similarity. Again, it is important to point out that much of the description of organisms in the text consists of comparative accounts and therefore assumes a similar/dissimilar distinction inherent in the formist root metaphor.

216R15-19 ("The human being . . .")

Analysis

This statement is subject to the same analysis as section 164R5-23. Organicism is judged to be projected because a non-functional organ is a contradiction in nature. The contradiction is resolved with a higher level of integration provided by the theory of evolution.

220L1-R28 ("RECEPTION OF COLOR BY CONES")

Overview

Pepper's account of the contextualist "verified hypothesis" concept of truth shows that truth lies in the hypothesis leading to a successful act. The verified hypothesis does not give insight into the reality and structures of nature. The analysis in this section concentrates on two statements that lend themselves to a contextualist interpretation.

Analysis

The first statement indicating the projection of contextualism is "this theory of Young and Helmholtz is verified by the phenomenon known as the after-image or complementary color effect" (220L46-48). The complementary color effect, then, is the successful act that verifies the hypothesis. Later it is said that "the Young-Helmholtz theory explains the after-image in the following way" (220R6-7). The wording of the latter statement suggests that the theory is useful to account for a phenomenon, rather than providing insight into the nature of reality. As discussed below, it would suggest something quite different, if after-image had been stated as evidence for the Young-Helmholtz theory.

Comment

Analysis of this section deals with two kinds of relationship between a theory and the phenomena to which it applies: (a) theory X accounts for (explains) phenomenon Y (no implication that the theory provides insight into the nature of reality); and (b) phenomenon Y is evidence for (buttresses, "proves," lends credence to) theory X (implication that the reality of Y suggests that X indeed provides some insight into the nature of reality). The distinction is important. Statements of the first type are consistent with contextualism, while statements of the second type are decidedly not.

To say that a theory accounts for a phenomenon is only to comment on the possible usefulness of the theory as an intellectual device. This is consistent with the contextualist emphasis on theory in the service of successful human action. But to say that some (real) phenomenon is evidence for (the correctness of) theory X is to suggest some correspondence of the theory with reality. This line of argument suggests that statements of type (a) project contextualism, while statements of type (b) project either formism, mechanism, or organicism. (Animism and mysticism do not hold "evidence" to be an issue.)

Chapter Nineteen

"The Reproduction of Organisms"

225L1-226R15 ("THE REPRODUCTION OF ORGANISMS")

Overview

The analysis of this section concentrates on the way the discussion of spontaneous generation projects mechanism. Before analyzing the discussion of spontaneous generation, it is worthwhile to analyze the contents of the first paragraph (225L1-18) to show the way in which formism and mechanism are projected.

Analysis

Formism is projected because "the reproduction of organisms" (225L1) is a generalization which depends on the observation of similarity among organisms. The generalization is developed more fully with subsequent discussion about asexual and sexual reproduction. These statements indicate that not just one organism is being discussed, but rather large numbers of organisms.

Mechanism is projected in this paragraph because observable qualities ("identifying traits of the new individual" [225L17-18]) are reduced to the manifestations of discrete particles ("molecular groups, called genes, are responsible for the . . ." [225L16-17]).

The remainder of the analysis concerns the arguments against spontaneous generation. The assumption of action-by-contact and the denial of spontaneous generation in favor of more scientific explanations is plain in the statement that "the ancient idea of the spontaneous creation of living matter has been discredited for there are now scientific explanations for all the examples of so-called spontaneous creation" (225R8-12).

There appear to be two major assumptions behind the argument against spontaneous generation in this section: like comes from like, and causality operates through action-by-contact. The first assumption is made explicit in the following statement: "all organisms, no matter how small, come from pre-existing organisms" (226L25-26). This assumption, while important to the argument against spontaneous generation, will not be pursued in depth here because it does not discriminate among the several world hypotheses.

The assumption of action-by-contact is evident in Redi's, Spallanzani's, and Pasteur's experiments. In each of these experiments it was assumed that some thing had to be somewhere to be able to cause something. Redi's experiment is illustrative and is summed by these two statements: "he placed some pieces of meat in the open and other pieces of the same meat under fine muslin cloth" (225R27-29); "since maggots appeared only on the exposed, fly-blown meat, Redi correctly concluded that they developed from microscopic eggs deposited by flies" (225R29-33). Here the conceptualization of the experiment assumes that action cannot be at a distance (i.e., that the flies would have to have contact with the meat in order for maggots to develop).

Finally, it is interesting to examine the statement that "no so-called 'life' principle had been destroyed because the broth was cool, and thus if spontaneous generation could have occurred it would have done so" (226R4-8). As was discussed earlier (22L9-R9), mechanism appears to be the only world hypothesis whose categories do not allow any notion of "élan vital" or "life-force;" hence, the denial of such a concept projects mechanism.

Comment

This analysis is complicated by the fact that terms are ambiguous (e.g., life-principle, spontaneous creation) and that the argument as presented in the text is not complete nor is it "clean." For example, issues about spontaneous creation are not necessarily the same as issues concerning life-principle, yet they are confusingly brought together in several statements, e.g.: "they insisted that boiling the broth merely killed the 'life-principle' and that, due to this, spontaneous creation could not occur" (226L17-20).

Chapter Twenty

"Reproduction of Flowering Plants"

233L6-R14 ("PERFECT AND IMPERFECT FLOWERS")

Analysis

Thus far in the analysis, transcendent formism has typically been projected; that is, the observation of similarity comes from natural objects growing according to the same plan.

This section projects immanent formism, although the root metaphor of similarity is still the identifying characteristic. In immanent formism similar events or objects are described and the results of the description are accepted literally. The following statement projects formism in that sense: "the corn plant has separate male, or staminate, flowers and female, or pistillate, flowers on the same stem" (233L13-R2).

Immanent formism is not projected in the discussion of the high bush cranberry (233R9-14). In that discussion it is clear that there is more than the literal acceptance of the description of the cranberry as an example of a plant with a neutral flower. Mere description is embroidered with explanation in the string "the sole purpose of which is to attract insects to inconspicuous fertile flowers clustered within the ring of the more showy neutral flowers" (233R11-14).

Chapter Twenty-One

"The Development and Growth of a Higher Plant"

240L1-R40 ("DEVELOPMENT OF A SEED")

Analysis

The analysis of this section shows several statements that project formism because of the assumption of similarity. "All life on earth depends on water" (240L13) is an example of a generalization made on the basis of the observation of similarity. In the description of the germination of a dicotyledon (240R7-40), formism is also projected because of the intuition of similarity.

However, beginning with the statement "as soon as extensive root and lateral root systems have been laid down . . ." (240R15-20), the categories of immanent formism seem most helpful in showing the way in which formism is projected. The discussion of germination in the lima bean consists entirely of description accepted literally, and in immanent formism similar events or objects are described and the results of the description are accepted literally.

243L1-R22 ("MONOCOTYLEDONOUS SEED . . .")

Analysis

This section is judged to project formism because it is primarily descriptive and because similar characteristics are noted in plants which permit them to be classified. Evidence of pure description is found in the statement that "the plumule, radicle and hypocotyl lie beneath the scutellum" (243L23-25). This descriptive quality to the discussion continues for the remainder of the section. It is clear from the following statement that the observation of similar root systems is, in part, the basis for classification: "the root system establishes itself and becomes an extensive fibrous root system, one of the characteristics of monocotyledonous plants" (243L35-R3).

244L12-17 ("Exactly how . . .")

Analysis

This statement is analyzed because it must be seen within the context of an issue discussed previously: "exactly how these identical meristematic cells, all containing the same number and kind of chromosomes, become the many types of specialized cell in the plant has not been firmly established" (244L12-17). The explicit reference here is to the problem of cell differentiation which has been discussed in the section on cell aggregation (48L1-R23) and heart development (137L6-R18).

In both of those sections a case was made for claiming the projection of an organicist world hypothesis and those arguments hold for this statement by implication. It is illuminating to quote three statements from those sections: "this aggregation of cells to form the tissues, organs, and systems of complex organisms is a phenomenon that raises living things far above non-living things and which clearly distinguishes living organisms from the rest of the universe" (48R18-23); "there are many occurrences within living organisms about which biologists know little or nothing..,. One of the most baffling of these is how individual cells in a growing embryo organize themselves into specific organs" (137R12-138L4).

244R24-42 ("A feature . . .")

Analysis

A formist world hypothesis is projected because the observation and description of similar characteristics serves as a basis for classifying dicots and monocots.

246R18-34 ("ROOT BRANCHES")

Analysis

Most of the statements within this short paragraph project formism because they are descriptions, accepted literally, and based on observed similarity, e.g.: "the meristematic tissue usually appears near the outermost parts of the xylem;...the branch growing point shows the same organization as the radicle" (246R25-29). However, embedded within these descriptive statements projecting formism is a statement that projects mechanism because of the reductive explanation of an observable phenomenon in terms of molecules (enzymes): "the branch grows through the cortical tissue of the root by means of enzymes secreted at its apex" (246R29-31).

251L6-9 ("Indeed, it can be said . . .")

Analysis

This analysis is of the statement that "all terrestrial animals are dependent, directly or indirectly, upon the food made in the leaves of green plants" (251L6-9). Because this statement suggests that organisms are not totally discrete entities and implicitly refers to the entire unit on "the interdependence of organisms," it is judged to project organicism. There is the suggestion of an organicist world hypothesis because of the concept of integration.

253L40-R34 ("GROWTH MEDIA")

Analysis

This section shows the projection of mechanism because the observable phenomenon of growth is explained in terms of discrete particles (certain chemicals). One example of mechanistic reduction occurs with the statement that "it is now known that an auxin is one of a number of chemicals that influence plant growth" (253L41-43). Another example is "other hormones, among them naphthalene acetic acid, will chiefly inhibit growth" (253R9-11).

Chapter Twenty-Two

"The Skeletal Systems of Plants"

255L1-259L29 ("THE SKELETAL SYSTEMS OF PLANTS")

Overview

The analysis of this short chapter shows the projection of formism arising from generalizations about classes of plants observed to grow according to the same plan (transcendent formism), and similarity of objects (plants) accepted literally (immanent formism).

Analysis

We may begin the analysis with the statement that "many dicotyledonous plants of intermediate height are supported by virtue of the tough, fibrous nature of their stems" (255L26-28). A common or similar characteristic (fibrous stems) is sometimes observed in a class of organisms (dicotyledonous plants) of which the sunflower (255L29) and hemp (255L35) are examples.

In the following statement formism is projected because a similarity is noticed among a class of organisms: "all plant cells begin life with cellulose walls" (255R2-3). Mechanism is projected in the following statement because of the explanation of an observable phenomenon (cellulose thickening) in terms of discrete particles: "in the case of cellulose thickening, sugar is converted to polysaccharides, which make up the long, chain [sic] molecules of cellulose" (255R11-14).

The statements in section 256R13-30 project immanent formism because a description is accepted literally. This is the case except for the first statement: "in the spring, new xylem vessels of large diameter are formed in order to accommodate the increasing volume of water absorbed by a tree now sprouting fresh leaves" (256L13-17). This is not literal acceptance of a description because it contains explanation. Formism is projected, however, because of the observation of similarity among certain organisms. The discussion of the formation of root hairs (259L8-15) projects formism because the results of a description (based on the observation of similarity among plants) are accepted literally.

Chapter Twenty-Three

"Respiration and Excretion in Plants"

261L1-262L18 ("EXTERNAL RESPIRATION")

Analysis

Mechanism is projected by some statements because observable phenomena are reduced to processes ultimately attributable to manifestations of discrete, inferred particles. One example is in this statement: "synthesis is anabolistic since it involves molecular building, while oxidation during respiration is a catabolic process whereby food is broken down into smaller molecules" (261L4-8). A formist world hypothesis is projected by the statement: "In green plants . . . anabolism and catabolism proceed at the same time" (261L8-11) because of the observation of similarity in a class of organisms.

The description of stomate operation projects mechanism because of reduction and because of the assumption of action-by-contact. Reductionism is implicit in the following statements: "since osmotic pressure due to the entry of water into a cell depends on the small size, solubility, and number of particles within the cell, the change of the small molecule of sugar (which is soluble) to the large, partly insoluble molecule of starch will reduce the osmotic pressure drastically" (261R26-32); "since the change of sugar to starch takes place in the hotter part of the day, the stoma will automatically close at a time when the transpiration rate is highest" (261R38-262L1).

An action-by-contact paradigm is assumed in these statements: "guard cells . . . are able to change their shape slightly and, in so doing, to regulate the size of the stomal opening" (261L36-R1), "the stoma will open as the increased turgidity of the guard cells causes them to alter their curvature" (261R19-21).

Chapter Twenty-Four

"Nutrition and Transport in Plants"

264L1-R15 ("PLANT NUTRITION")

Analysis

The analysis of this section shows the projection of mechanism because of reduction and quantification. Reduction, for example, is evident in this statement: "the radiant energy from the sun enables the chemical bonds of carbon dioxide and water to be broken and other chemical bonds to be created in order to regroup the atoms of carbon, oxygen, and hydrogen to form glucose and oxygen" (264L19-24). It is clear from this statement that discrete particles are important in the explanation of processes contributing to observable life.

Quantification projects mechanism in the statement: "It has been estimated that the average, broad, green leaf produces 0.02 grams of sugar per daylight hour" (264L24-27). The description of nutrition contains quantification for the sake of understanding the process. Quantifying aspects of a description (in this case mass and number) project mechanism.

Chapter Twenty-Six

"Classification"

277L1-36 ("INTRODUCTION")

Overview

As a prelude to detailed analysis of specific statements, this overview discusses some of the basic issues that arise from this chapter's treatment of classification. Both formism and contextualism are projected strongly in this chapter. Formism is projected because the basis for classification rests in the intuition of similarity--the root metaphor of formism. For the most part this intuition manifests itself in the strict observation of similarity (immanent formism), although later classification assumes a continuity provided by evolution and therefore projects the observation of natural objects growing according to the same plan (transcendent formism).

Contextualism is projected because of the stress on making clear that there are no absolute classificatory schemes and that the results of classification are changeable. This is appropriate to contextualist categories which see such schemes (laws, maps, diagrams, equations, etc.) in terms of human usefulness--that is, in the context of human action.

But it should be pointed out that even with the projection of a contextualist world hypothesis the basis for classification is still the intuition of similarity. Therefore, it seems appropriate to generalize that, for the most part, when formism is projected it is projected because of the intuition of similarity seemingly inherent in all classification schemes. When contextualism is projected it is because of the attitude taken toward such schemes.

Analysis

The observation of similarity and consequent projection of formism is implied throughout most of this section and the basis for classification (similarity) is explicit in this statement: "today's system of grouping organisms is based on the relationships between organisms and their structural and physiological similarities" (277L15-19).

The projection of contextualism comes from the implication that classification is useful and that classification schemes are changeable. The implication that classification schemes are useful is suggested in "to confront the study of such a vast array of living things . . ." (277L9-13). Here it is implied that classification is for the purpose of . . ., rather than implying that it reveals something existent and inherent in nature. The idea that classification schemes are changeable is implied in this statement: "lately, however, there has been a tendency to seek other relationships not immediately observable and often based on assumptions of evolutionary developments" (277L22-26).

Comment

With reference to the last statement analyzed (277L22-26), while it does imply change and flexibility in classification little indication is given as to why classification schemes do change. They could change, for example, because a new scheme is more useful (implying contextualism), or because a new scheme more accurately reflects what is existent in nature (implying formism). A stronger case could be made for formism if recent changes were said to be the result of "assumptions of evolutionary development" (277L25-26), but there is no evidence for that in this section.

278R1-51 ("Ray defined . . .")

Analysis

The analysis of this section concentrates on two statements which imply a contextualist world hypothesis. "Ray defined a species as a group of individuals having a common ancestor and able to breed among themselves" (278R1-3)--this projects contextualism because "defined" implies that classification schemes are constructed and do not result directly from the observation of reality. "However, the binomial system has been retained because of its usefulness in naming species" (278R37-39)--this projects contextualism because "usefulness" implies that the basis for using a particular scheme lies in the context of human action.

279L30-47 ("MODERN CLASSIFICATION")

Analysis

Contextualism is projected in the statement: "just as there are no absolute laws of nature, only man-made ones, so there is no absolute system of classification except a man-made one" (279L39-43). This position betrays a contextualist world hypothesis, in which schemes are considered instruments of man which, rather than giving insight into the nature of reality, must be seen in the context of human action.

However, the succeeding statement that schemes and laws are modified as we learn more about nature (279L43-47) is subtly non-contextualist in that it implies that there is a static reality which is discovered and laws, schemes, etc., describe that reality. Such a position could project formism (correspondence with reality) or organicism (successive approximation toward absolute truth), but it does not project contextualism.

Chapter Twenty-Seven

"The Protistan Kingdom"

Overview

This brief overview of the entire chapter is to highlight the context in which the chapter should be read. This chapter is within the unit "Classification of Organisms" and follows Chapter 26, "Classification." Consequently, the entire chapter utilizes a scheme of classification developed in the previous chapter. The assumption of that scheme of classification of course also entails the intuition of similarity that provides a basis for classification schemes. As a result there is an overriding projection of formism in this chapter because discussion takes place within the context of a classification scheme.

However, other world hypotheses are also projected. In several places mechanism is projected because of reduction; and contextualism is projected because of the relativistic attitude toward schemes of classification.

283R12-284L12 ("[illegible] first electron micrographs . . .")

Analysis

The analysis of a statement in this section and several other statements outside this section shows the projection of a mechanistic world hypothesis primarily because of the reduction of observable phenomena to discrete, inferred particles. The first statement is: "the tiniest of living organisms was apparently little more than a very large collection of protein molecules with no evidence of a cell wall, cytoplasm, a nucleus, or any other part of a living cell" (283R13-284L3). This statement is judged to project mechanism because the description of viruses is in terms of molecules. This mechanistic reduction is again seen in the statement that bacteria "possess a cellulose wall made up of threads of complex sugar molecules" (288R5-7).

The preceding analyzed statement (288R5-7) projects formism, of course. From context it is clear that a generalization is being made about all bacteria, based on the observation that there are certain ways in which bacteria are similar.

Mechanism is projected because of reduction in this statement about observable contraction movements in Vorticella: "the fact that deprivation of oxygen results in slower and slower contractions would indicate that respiratory energy is required for the usual ADP-ATP reaction" (291R12-16).

Color Plate ("A CLASSIFICATION OF ORGANISMS")[1]

Analysis

Analysis of the eight lines of text accompanying this color plate illustrates the usefulness of distinguishing between a basis for classification (intuited similarity--formism) and attitudes toward classification schemes (useful to man--contextualism). From the context of the preceding chapter the classification scheme shown on the plate itself projects formism because similarity is its basis. However, contextualism is projected because of the implied attitude that such schemes have no existence in nature and are "real" in the context of their usefulness to man. The claim that a contextual attitude is taken toward classification schemes is supported in the analysis of earlier statements, such as: "just as there are no absolute laws of nature, only man-made ones, so there is no absolute system of classification except a man-made one" (279L39-43), and "the binomial system has been retained because of its usefulness in naming species" (278R37-39). The attitude that there is no single classification scheme is continued here in the assertion that this scheme constitutes "a method by means of which living organisms may be grouped" (1-2). This attitude is further supported in: "there is, at the moment, no international agreement on a single system of classification" (2-5).

295L1-296L29 ("THE FUNGUS GROUP")

Analysis

This section projects formism because of the observation that similarity among certain organisms allows them to be classified.

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[1] Appendix V, p. A278.

For example, in the statement that "all are characterized by the absence of chlorophyll" (295R3-4), a similarity among certain plants is observed that allows them to be classified as fungi. Formism is also projected because of the purely descriptive and observational aspect of statements such as: "The Basidiomycetes are sometimes known as the 'club fungi' because of the shape of the sacs that extrude the spores" (296L25-28), and "these fungi are septate . . ." (296L28-29).

It is worthwhile to notice the projection of mechanism in this section because of the quantification of phenomena as an essential part of a description. It occurs in the following phrases: "25% of all the non-animal species;" "no less than 70,000 species;" "15 pound puff-balls" (295L12-17).

Chapter Twenty-Eight

"The Plant Kingdom"

305L1-306L24 ("PHYLUM PHAEOPHYTA")

Overview

Since this chapter is within the unit on classification and its content is presented according to classes of organisms, formism is projected because of the intuition of similarity that is assumed in classification schemes. Sometimes this intuition of similarity is of a transcendent nature--e.g., natural objects growing according to the same plan. At other times, the intuition of similarity is manifested in the pure description of similar objects. Formism is projected in either case.

Analysis

An example of the projection of formism because of the implication of natural objects growing according to the same plan occurs in the following statement: "all members of this group are multicellular and show some morphological differentiation into epidermal and root type cells" (305R6-9). This statement exemplifies the formist position that a class is a collection of particulars that participate in one or more characters. In this case the "class" is a phylum; the "collection of particulars" are the organisms in the phylum which participate in the characters of multicellularity and epidermal/root cell differentiation. Another characteristic in which this group participates is the possession of sex organs: "sex organs are a characteristic structure" (305R9-10).

There are also statements (including the ones just analyzed) that can be seen as pure descriptions of similar objects. Here the "similar objects" are the members of the phylum Phaeophyta. A statement, such as "the extremely long stems of the Sargasso weeds are supported by buoyant bladders" (306L1-3), is purely descriptive as is the statement "sexual reproduction involves motile sperm released from bladders near the ends of the branches of an alga such as Fucus" (306L22-24).

Contextualism is also projected in this section because of the reference to a contextualist attitude toward classification schemes. The idea that such schemes are useful for the purposes of man and do not necessarily represent an objective reality has been discussed previously (pp. A132-A134). A related idea is that there is no single "correct" classification scheme, and consequently several schemes may be useful. The notion that there may be more than one acceptable scheme is reinforced by the phrase "according to the system of classification followed in this text" (305L3-4).

308R6-309L25 ("PHYLUM TRACHEOPHYTA")

Analysis

Formism is projected in this section because similar characteristics are the basis for classification, as is seen in this statement: "it is because pine and other coniferous trees produce naked seeds that they are grouped in the class Gymnospermae . . ." (309L21-24). The pure descriptive character of parts of some of the statements in this section projects immanent formism, e.g.: "the spores and subsequent gametes are borne on large plant bodies" (308R24-309L1), and "the seeds are borne naked on the surface of the scale leaves of female sex organs" (309L14-16).

311L36-40 ("Each leaf scale . . .")

Analysis

The analysis of this short section is to highlight the pure descriptive nature of some statements. Again, in immanent formism similar events or objects are described and the results of the description are accepted literally. The literal acceptance of a pure description is quite clear in a statement such as "surrounding the egg is a small archegonium" (311L37-38).

Chapter Twenty-Nine

"The Animal Kingdom"

Overview

The analysis of this chapter shows the projection of formism and contextualism. That is, the trend noticed in the last two chapters (intuition of similarity, relativity of classification schemes) is seen here also. Organicism is projected insofar as the discussion of animals according to increasing complexity implies a corresponding increase in the integrated functions of cells, tissues, organs, and systems. Evidence for the projection of organicism, then, lies partly in the structural layout of the chapter (simple to complex), and also in implicit references to previous discussions which projected organicism because of the implication of integration (e.g., 174R3-34, pp. A111-A112).

323L1-324L19 ("INTRODUCTION")

Analysis

An example of the projection of organicism is the following: "these mechanisms include a sensory and nervous system to make the animal aware of food and to co-ordinate its movements in order to capture food" (323R7-10). The coordination of sensory, nervous, and muscle systems to perform a specific function implies a high degree of integration and consequently projects organicism. This idea is again conveyed in 324L5-19, especially with this statement: "a number of different organs operating together to carry out a specific function is known as a system" (324L15-17).

Comment

The same line of thinking that suggests the projection of organicism from "the co-ordination of several systems to capture food" can be generalized to the phenomenon of life. Accordingly, all cells, tissues, organs and systems are complexly integrated to produce a whole which has the quality of life. (The difficulties with Pepper's organicism still hold, and Pepper's selectivism or Laszlo's systems view seem more appropriate.)

Alternatively, the phenomenon of life could be explained in terms of atoms and molecules as has been implied in this text in several places. The issue is clearly not a black and white one, however, but one of emphasis. The organicist stresses integration, the mechanist stresses discrete particles located in space and time. While this paragraph (324L5-19) certainly does not rule out atoms and molecules, the implications tend toward organicism. On the other hand, this paragraph can be interpreted as implying a reductionist perspective, thus projecting mechanism.

324L20-R52 ("THE ANIMAL KINGDOM")

Analysis

This section shows the projection of formism because of the intuition of similarity, and contextualism because of the attitude taken toward classification schemes. The basis for classification is seen in paragraph 324R9-16. The first statement (324R9-14) shows a description of similar objects, and the last statement ("these characteristics place it in the class known as the Insecta" [324R15-16]) shows that a class is a collection of particulars that participate in one or more characters.

Three statements lend themselves to a contextualist interpretation, and consequently are said to project a contextualist world hypothesis: "the definition of a species, namely, individuals of a group in which interbreeding can take place, applies as much to animals as it does to plants" (324L37-40); "it should be stressed again here that animals are artificially grouped by man in order to facilitate the study of the myriad types" (324R47-50); and "no one method of classification has universal approval, as will be evident from further reading" (324R50-52). The first statement indicates that the delineation of "species" in classification schemes is a matter of definition and not a matter of inspecting reality--implying that such definitions are for the purpose of human action. According to the second statement (324R47-50), human action in this case is "the study of the myriad types." The last statement points out that there are several methods of classification and implies (within the context of the other two) that this situation exists because of the contextualist attitude toward classification.

Comment

The comment that there are several methods of classification points to a problem discussed earlier (277L1-36, on pp. A132-A134). It could be that several schemes exist because each is useful in its own way for making sense out of large numbers of organisms (contextualism). On the other hand, there could be several schemes because several investigators perceive reality differently and hold that the schemes correspond to the reality they perceive (formism). Little evidence is to be had for either interpretation except that the admission of several methods of classification points to a contextualist attitude toward classification schemes.

331L1-R8 ("TRIPLOBLASTIC METAZOANS")

Analysis

Contextualism is judged to be projected in the first paragraph (331L1-27) because of the implication that man-made schemes are not necessarily representations of reality. Again, a contextualist world hypothesis is projected because of the attitude toward classification schemes and not because of the basis for classification.

The statement that "this type of nervous system is an improvement on the broadcast type of the coelenterates because it enables the animal to react in a specific way to local stimulus and to coordinate its movements" (331L46-50) projects organicism because of the implication of integration of systems in coordinated movement (see overview of this chapter with reference to 174R3-34, pp. A111-A112).

331R10-16 ("At one time . . .")

Analysis

The analysis of a single statement (331R13-16) shows the projection of both formism (basis for classification schemes) and contextualism (attitude toward those schemes). The statement "today, the tendency is to separate the worm-like animals into about 12 phyla" (331R13-15) projects a contextualist world hypothesis because it indicates a degree of flexibility in classification schemes and implicitly reinforces the relativistic attitude taken toward classification schemes in 324R47-50. However, the clause "because of the distinct and obvious differences between the various species" (331R15-16) projects formism because a concept of similarity/dissimilarity must be assumed before distinctions among organisms can be made.

Comment

"Distinct and obvious differences" (331R15-16) presumably have always been observed (that is why they are obvious) and yet the implication is that only now is there a tendency to change the classification. Why only now? Possibly it is because it is useful to do so ("in order to facilitate the study of the myriad types," [324R49-50]). On the other hand, a formist might say that tendency is motivated (perhaps in the light of new information) by the revised scheme's better fit with reality.

324L44-357L44 ("The remaining molluscs . . .")

Overview

This section shows the projection of a formist world hypothesis because the results of a description are accepted literally, because similarity is the basis for classification, and because it is suggested that natural objects grow according to the same plan.

Analysis

The description of molluscs (assuming their similarity) and their classification according to similar characteristics projects formism in 324L44-R2. The observation of similarity is also the basis for the statement that "all insects possess three main body parts, head, thorax and abdomen" (350R1-2). The observation of similarity as the basis for classification is also evident in 351L22-R50.

The literal acceptance of a description is clear in the account of the squash bug (357L19-44): "the young nymphs resemble their parents except that they are more vividly colored and do not possess wings" (357L25-27).

Chapter Thirty

"Evolution"

369L1-370L23 ("ORGANIC EVOLUTION")

Analysis

This section shows the projection of contextualism and formism. One of the first hints of the projection of a contextualist world hypothesis comes with the statement that "the modern theory of the evolution of the various species of organisms is that these organisms are the result of a gradual change in living forms over a period of thousands of millions of years" (369L7-11). From this statement it is clear that change is an assumption upon which the theory of evolution rests. This idea of change projects contextualism because change is a basic category of a contextualist world hypothesis.

It must be made clear, however, that the judgment depends on what is the focus of the discussion. For example, if the focus is on kinds of organisms, then contextualism is projected (as has been argued) because those kinds change. On the other hand, if the focus is on the process of evolution, then that could be construed as a relatively non-changing form (e.g., the formist interpretation of laws). It seems clear that the focal point of this statement (369L7-11) is kinds of organisms.

The next statement analyzed is that natural science is "a continuous search for truth as revealed by observation and interpretation of this universe" (369R12-370L1). It is helpful to analyze the statement in two parts, first: natural science is "a continuous search for truth as revealed by observation" (369R12-13). This phrase projects formism because of the implication of a correspondence theory of truth in which observation plays a key role. The term "observation" points to the historical aspect of correspondence theory in which truth concerns existence and consists of describing characteristics of particular events.

However, this judgment is tempered, if not contradicted, by considering the phrase "and interpretation of this universe" (370L1). Here, contextualism is projected because of the assumption of a conceptual framework through which the interpretation is made. For the whole statement, it is nearly impossible to say which world hypothesis is projected. It is a question of emphasis. For the most part the statement suggests contextualism (for support by context, see succeeding statements, 370L2-7) and "interpretation" is an important qualifier. Yet the meta-message in "search for truth as revealed by observation" is strongly formistic.

A contextualist position is projected in the statement that "the so-called laws of nature are man-made, based on our interpretation of observed data" (370L2-4) because of the implication that laws are instruments of man and must be seen in the context of human action. This position is reinforced by the statement that scientific laws are not regarded as absolute (370L4-7).

However, the statement that laws "have had to be modified or abandoned as we have discovered more about nature" (370L7-10) implies that laws correspond to reality and, as reality is uncovered, the laws must be changed in order to maintain the correspondence. Therefore, this statement is judged to project formism. It seems doubtful from prior context that Toulmin's contextualist use of the term "discover" is meant here--that is, "discovery as a unique way of looking at familiar phenomena."[1]

The analysis of this section concludes with an examination of the question "what is the prime evidence to support the idea of organic evolution?" (370L22-23). This analysis concerns the comment on section 220L1-R28 (pp. A120-A122) where it was argued that statements of the form "Y is evidence for theory X" tend to project a formist world hypothesis, while statements of the form "theory X accounts for Y" tend to project contextualism. This statement (370L22-23) is of the first type and therefore is said to project formism.

372L1-374L18 ("EVIDENCE OF ORGANIC . . .")

Overview

Formism is projected in this section because of the assumption of similarity and because of the implications of speaking of "evidence" for evolution." Organicism is projected because of the integration of an apparent contradiction in nature into a more coherent, whole explanation. This refers to the phenomenon of vestigial organs and was discussed briefly in the analysis of section 164R5-23 (p. A106).

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[1] Stephen Toulmin, The Philosophy of Science (New York: Harper & Row, Publishers, 1960).

Analysis

This investigator has argued that statements of the form "Y is evidence for theory X" project a formist world hypothesis. This general form is displayed in "EVIDENCE OF ORGANIC EVOLUTION FROM COMPARATIVE MORPHOLOGY" (372L1-3). The same form is displayed in four remaining sections: evidence from geographic distribution, comparative anatomy, comparative embryology, and breeding.

The observation of natural objects growing according to the same plan is the basis for the projection of formism in the following statement: "examination of the fossil remains of imprints of extinct animal species very often reveals a similarity in the basic structural plan of the various types within phyla and classes" (372L4-R2).

An organicist world hypothesis is projected because the observation of vestigial organs (fragments implying contradiction) are explained by and more fully integrated into a theory of evolution (a more fully integrated organic whole). This is projected strongly in two statements: "serial homology thus affords more evidence of gradual evolutionary development either forward or backward," and "when viewed in this light, certain rudimentary and very often useless structures take on a new meaning" (374L1-7).

385L30-R44 ("THE MECHANISMS OF EVOLUTION")

Analysis

One of the features of this section is the projection of a mechanistic world hypothesis because observable phenomena are reduced to explanations involving discrete inferred particles, e.g.: "there is a continual reshuffling of genes in the chromosomes, which results in the rearrangement of variable traits such as skin and eye color" (385L39-R1).

A contextualist world hypothesis is projected because of the form of this statement: "This [illegible]ffling of variable traits could not be accounted for by Darwin" (3[illegible]). The statement is of the general form "theory X cannot account for Y" and, therefore, is judged to project contextualism.

In light of the current creation/evolution controversy in science education (pp. 103-111 of this study), it is appropriate to highlight the obvious fact that an animistic world hypothesis is not projected in these statements. The discussion of the variety of organisms in terms of organic evolution precludes the possibility of the projection of animism.

Chapter Thirty-One

"Heredity"

386R1-387L20 ("Of all the human . . .")

Analysis

A mechanistic world hypothesis is judged to be projected in this section because of the reduction of observable phenomena to explanations involving discrete, inferred particles. The following statement illustrates the point: "Genes, the arrangements of molecules within the chromosomes that determine physical and chemical features of the individual, are the identities with which we deal in discussing human traits" (386R6-11). A similar reduction is evident in this statement: "These inherited characters not only include physical and chemical attributes governing the build and functioning of the organism but also determine predispositions to certain diseases" (387L7-11).

Mechanism is also projected incidentally (i.e., through the pedagogical device used) because of the extensive and elaborate use of quantification in an analogy intended to provide better understanding for the concept of gene combination in human beings (386R11-387L4). Further, a mechanistic world hypothesis is projected incidentally by the analogy of organs to automobile parts (387L15-20).

387R4-394R4 ("Very little was done . . .")

Overview

This section projects a formist world hypothesis because of the attitude toward natural laws. In formism, natural laws are considered as existent forms in nature and the aim of science is to discover the laws which nature follows. This notion of "discover" is the primary ground for the claim that this section projects formism.

Analysis

A key statement to support the claim that formism is projected is the following: "One must admire the honesty and principles of the three men in giving full credit to Mendel for the discovery of the laws of heredity" (387R25-28). The same sense of discovery is present in: "Mendel had not been alone in trying to discover how living things inherited certain features" (387R44-46). These statements provide a context for the next two headings: "MENDEL'S DISCOVERIES," 388R18--according to 387R25-28, Mendel discovered the laws of heredity; "MENDEL'S LAWS," 389L21--according to 387R25-28, the laws that Mendel discovered.

Two statements only slightly temper a claim for the projection of formism. That first is "this law was not established by Mendel" (389R28). The use of the term "established" suggests a somewhat more contextualistic interpretation because of the implication of that conceptual frameworks (and selective biases) are involved in the "establishment" of ideas. Also, the last statement of this chapter (394R1-4) suggests that the laws of heredity have a useful function in the context of human action. This last statement has less implication of formism than do those which speak of Mendel's discovery.

Chapter Thirty-Two

"Genetics"

395L1-397R28 ("INTRODUCTION")

Overview

The analysis of this section shows the projection of a mechanistic world hypothesis because of reduction and location.

One of the clues to the projection of mechanism is the explanation of observable physical features of organisms in terms of inferred particles such as atoms making up the structure of DNA. Midway in the reduction, however, are a number of particles (cells, nuclei, chromosomes, genes) which are important in explaining observable features of organisms. Concurrent with reduction is the obvious effort to locate the cause of genetic phenomena.

Analysis

The effort to locate parts of the hereditary mechanism is evident in this statement: "In it he proposed that inherited traits might be passed from parent to offspring by means of rod-like bodies which he had identified in cell nuclei" (395L27-30). Location is again an issue in the statement that "What was needed now was evidence of the presence of genes within these chromosomes" (395R39-41). It is also an issue in: "Morgan's examination of these chromosomes . . . revealed dark cross bands that could well be the missing genes" (396L13-17).

An example of the projection of mechanism by reduction of observable phenomena to explanations involving discrete particles, occurs in the account of Morgan's work with vestigial fruitfly wings: "His belief was that genes were arrangements of certain kinds of molecules within the chromosomes and that something in the environment could somehow alter the structure of these molecules resulting in an alteration in the development of a fly" (397R22-28).

Finally, it is worthwhile to notice that the "X accounts for Y" form of the following statement projects contextualism: "The science of genetics seeks to account for variation among the individuals of a species due to environmental and genetic factors" (395L2-5).

407L19-R10 ("DNA: THE MATERIAL OF HEREDITY")

Analysis

Mechanism is projected in this section because of the reduction of observable phenomena to discrete particles. Two statements show this reduction particularly well: "It is the ability of DNA to reproduce, or replicate, itself that has made it possible for all the various forms of life on earth to develop" (407L23-27); "It is now known that we are as we are because of the arrangement of atoms in about one ten-trillionth of an ounce of DNA inside sperm and eggs" (407R3-6). Here, the discrete particles are clearly stated--DNA and atoms in DNA. The observable qualities are "forms of life on earth" and what "we are."

409R12-410L35 ("WATSON AND CRICK,1953")

Analysis

Several statements in this section project mechanism because quantification is an important aspect of the description of DNA: "the molecule has a mean diameter of 1/10,000,000 mm and a length of 1/10,000 mm" (409R19-21); "it was a molecule 1000 times as long as it was wide" (410L29-30); "The genes . . . were composed of from 500 to 2000 nucleotides, or bases, and the total number of nucleotides per chain was . . . in the region of 200,000 in the case of virus DNA" (410L30-35).

Contextualism is also projected to the extent to which "postulating a model" implies the use of conceptual frameworks for the purpose of explanation--that is, the postulation of a workable or useful model implies that reality is not "given" and that such models are to be understood in the context of human activity. Several statements refer to the postulated model: "the two men were able to propose a model" (410L8-9); "This model of a DNA molecule . . ." (410L9-10); "Watson and Crick . . . were able to postulate that it was a molecule 1000 times as long as it was wide" (410L26-30).

Chapter Thirty-Three

"The Interdependence of Organisms"

419L1-438L52 ("INTRODUCTION")

Overview

Organicism is projected in this chapter not only in the meaning of individual phrases, sentences, and paragraphs, but in the structure of the chapter. Therefore, it is convenient to analyze this chapter as one section.

The judgment that an organicist world hypothesis is projected rests primarily on the root metaphor of organicism (integration) and the category organic whole. The intuition of wholes is also a prominent feature of contextualism and consequently it is sometimes difficult to distinguish the projection of these two world hypotheses. Generally, however, the investigator's interpretations favor organicism in this chapter because integration and "organic whole" are closely associated throughout.

The problems with Pepper's treatment of an organicist world hypothesis and its application to a biology text have been discussed previously, with regard to the analysis of section 171R12-173R8 (pp. A109-A111). The analysis of the present section again suggests that the categories of organicism are inadequate to capture the total flavor of what is projected to students. Nevertheless there does appear to be a projected view in this section that is not very adequately accounted for in terms of formism, mechanism, animism, mysticism, or contextualism, but is more adequately accounted for by an organicist perspective.

The analysis of this section concentrates on showing the projection of organicism because of the emphasis on wholes (cycles, populations, ecosystems) and the integration of fragments (e.g., an organism) necessary to the integrity of the whole. Also, there is a hierarchical structure in which the fragments of one whole are themselves wholes made of integrated fragments. Integration is implicit in such terms as "food-web," "interrelationship," "interdependence," and "ecosystem."

Analysis

Organicism is projected in the statement: "This book ends by considering the way in which living things are related to, and come to depend upon, other living things and the earth's physical environment" (419L15-18). This notion of interdependence and consequent implication of integration is also projected in: "water has a number of functions that make it indispensable to life" (419R1-3).

The discussion of cycles implies the integration of fragments to produce a viable whole system. This implication is summarized in the statement: "These two processes complement each other and thus form an energy cycle" (419R32-34). If a cycle is considered a whole, then molecules, organisms, and physical features are fragments integrated into that whole. These cycles, in turn, are fragments which are integrated into larger organic wholes, such as the ecosystem. The whole of the ecosystem loses its integrity if the fragments (e.g., cycles) are missing.

A hierarchy of integrated wholes is implied in the following statements: "All the animal life on earth is dependent on the ability of green plants to synthesize food" (420R2-4); "In order to synthesize food, plants subtract carbon from the traces of carbon dioxide in the atmosphere. This carbon must be replaced or the cycle is broken and no further food can be made" (420R11-15). From these statements and from FIG. 33:1 ("CARBON CYCLE"), processes (photosynthesis, respiration, decay) and things (organisms, seas, oceans, factories, etc.) can be seen as fragments which are integrated to form a larger whole (carbon cycle) which in turn can be seen as a fragmented process integrated into the ecosystem, as are all biotic and abiotic features. All are necessary to the viability of the ecosystem as a whole.

The idea of an integrated system is reinforced by such a statement as this: "No organism is independent of its environment or of the other living things around it" (432R34-36). And a concept of integration is implicit in the following two statements: "In a stabilized community every individual has its ecological niche and its part to play in the balanced pattern within the ecosystem. Remove a dominant species from this community and you change the nature of the community by upsetting the established equilibrium" (432R36-433L6). In these statements, "established community within the ecosystem" is the integrated whole which is changed if the fragments are altered.

The discussion of populations (423L13-424L35) projects organicism because population is a whole made up of fragments (individual organisms). Holism is expressed in the explanation that descriptive features of a population are not applicable to the fragments, but only to the whole, e.g., birth and mortality rate, or age distribution. This is an example where Laszlo's system view (postulating laws which hold uniquely for wholes and are not applicable to the parts) could be useful in accounting for discussions based on the concept of population.

Change and novelty are basic to a contextualist world hypothesis. Contextualism denies absolute structures or inherent order in the universe, and that position is projected in the following statement: "In this world of ours, and in the universe around us, nothing ever stands still or remains changeless" (420L26-28).

A mechanist world hypothesis is projected in the following: "Man is far less dependent on his physical environment . . ." (437R43-47); "Man does not have to exist in a balanced biotic community . . ." (437R47-49); "His success, in fact, can be attributed to his relative independence of his environment and the living things around him" (438L1-3). Mechanism is projected in these statements because of the mechanistic notion of discrete entities. The concept of man is seen here as unrelated to concepts such as ecosystem or environment. This projection is unique because it occurs in a chapter which stresses interdependence and interrelationship among concepts such as organism, cycle, environment, ecosystem, etc.

APPENDIX V, PAGES A160-A317 WERE REMOVED FROM THIS DOCUMENT PRIOR TO ITS BEING SUBMITTED TO THE ERIC DOCUMENT REPRODUCTION SERVICE.